AN INVESTIGATION INTO THE LINK BETWEEN AUDITORY PERCEPTUAL SKILLS - SPECIFICALLY THE PERCEPTION OF RHYTHM PATTERNS, AND READING (DIS)ABILITIES

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ABSTRACT

The skill of Reading may be recognised as being at the top of the hierachy of language based skills. As such, it is subserved by a number of contributory abilities of which one of the most important is auditory perception. Auditory perceptual ability is distinguished from auditory acuity in that the former is the process by which auditory stimuli are received and understood. Auditory acuity alone is merely the recognition of an auditory stimulus having occurred i.e., the threshold of hearing.

The assessment of auditory perceptual abilities (including auditory discrimination, auditory memory, auditory blending, auditory-visual integration, and auditory comprehension) during early childhood may be recognised as a valuable predictor of subsequent reading achievement. Children who suffer some degree of reading disability have been found to perform less well on such auditory tasks when their performance is compared to that of their non reading disabled peers. This inferior performance has been noted as having occurred both during the period of early reading education, and at the pre-reading level.

The current study, however, failed to find a significant difference between a group of 9 - 11 year old reading disabled children and a similarly aged group of non reading disabled children, on the Seashore Rhythm Test. This test requires the perception of auditorily presented rhythm pairs and subsequent identification of the presented pairs as being either the "same" or "different". A difference within the suggestive range of significance was found, however, between the performances of the males and those of the females with the females performing the task better than the males. In particular, this finding regarding the differences between the perceptual abilities of the sexes provides some support for the issue that the majority of children who experience reading disabilities are male.

Some reasons as to why a non significant difference was found between the reading ability groups and a difference suggestive of significance was found between the sexes, in this study, are postulated.

INTRODUCTION

A. THE ROLE OF AUDITORY PERCEPTUAL SKILLS IN THE ACQUISITION OF LANGUAGE AND READING ABILITIES

In an extensive meta-analysis of the area, Kavale (1981) examined 106 studies which had attempted to relate various aspects of auditory perception with reading achievements. He considered an "analysis of analyses" as the best option when attempting to summarise the studies which he saw as being divided into three categories i.e., i) those which compared "good" and "poor" readers on various auditory perceptual skills e.g., Golden & Steiner (1969), ii) correlation studies which examined the relationships between the two fields e.g., Dykstra (1966), and iii) predictive studies which examined the relationship between beginning auditory perceptual abilities and subsequent reading achievement, e.g., McNinch & Richmond (1972). Due to the wide variety of research designs, subject selection procedures, and criterion measures used, interpretations were sometimes difficult but Kavale saw that a statistical summary of the literature could provide "an empirical statement" about the relationship between auditory perception and reading achievement.

Kavale's collection of statistics represented approximately 18,000 subjects with an average age of 7.86 years and average IQ of 106.73. He found evidence of five auditory perceptual skills which were significantly related to reading ability, i.e., i) auditory blending, ii) auditory memory, iii) auditory-visual integration, iv) auditory comprehension, and v) auditory discrimination. The magnitude of association with reading achievement for each of these skills ranged from 10% to 16%, with no significant difference being found between the individual correlations. In other words, each of the above auditory perceptual skills was of approximate equal strength when associated with reading ability.

The IQ variable was found to be significant both as a determinant of reading ability and auditory perception with the result that when this influential variable was partialled out (i.e., it was held constant) the magnitude of the relationship between the two factors decreased. Only the relationship between auditory discrimination and general reading achievement remained significant, with the implication that auditory discrimination is the only auditory perceptual skill which retains some independence from IQ in relationship to reading ability. Whilst intelligence shares a large part of the variance in the relationship between reading ability and auditory perception (especially with regard to auditory blending, auditory comprehension, and auditory memory), its effect is felt least in the relationship between auditory discrimination and reading ability.

When single and combined factors of auditory perceptual skills were investigated, moderate proportions of the total variance in reading ability were explained. As such, this also implies that factors <u>other</u> than auditory perceptual factors are influential in reading achievement. However, auditory perceptual abilities are sufficiently related to subsequent reading achievement to be considered to be of some predictive use.

In summary Kavale surmised that a complex relationship existed between the fields of auditory perception and reading achievement. Debate and controversy continue regarding the exact nature of this complex relationship, resulting in what Kavale referred to as

> ... a situation where "findings" abound but "understandings" are elusive. (p.539)

He concluded that as well as thorough assessments in other areas, an investigation and assessment of auditory perceptual areas should be considered as a valuable predictor of reading achievement. If we are to accept that auditory perception is the foundation upon which further language development is based, the idea of early auditory perceptual assessments (not merely acuity assessments which test the threshold for hearing) aiding subsequent identification of children who may be "at risk" of possible later reading deficits, would be of considerable interest.

(I) THE IMPORTANCE OF ACQUIRING EFFICIENT READING SKILLS, - IMPLICATIONS FOR EARLY EDUCATION.

When a child either fails to learn to read or experiences deficits in his/her reading achievement level, to where do we turn to identify possible causes? This dilemma becomes even more perplexing when such problems occur despite the best of intentions and efforts from school and home, and in the absence of primary visual and/or auditory dysfunction (i.e., primary hearing or vision impairment), or primary emotional disturbance. An appreciation of the fact that reading is part of the whole language process (indeed it may be recognised as being at the top of the hierarchy of language skills) helps us to appreciate the many contributory factors involved which lead to reading. It is not only necessary to investigate the child's reading ability per se, but also to examine the many processes which underlie the development of this exacting skill. The process of reading involves, among other things, an interaction of visual skills and abilities, recognition, comprehension, and memory abilities. Not only must one recognise, decode and encode the printed text (in its many and varied forms), but also remember what has been read, comprehend the meaning of the text, and incorporate this within the larger framework in which one is reading.

An important differentiation should be made, at this point, between reading per se, and simple word recognition. Whereas word recognition involves merely the visual and/or auditory recognition of a presented word stimuli, reading involves an interaction of recognition and comprehension, resulting in a meaningful interpretation being made of the text. This indeed is no simple task, especially when we consider that such a skill is usually expected of the very young child in his/her first year(s) of schooling. For this very reason also, it is important to be able to identify and differentiate between those reading problems which are possibly attributable to auditory perceptual disabilities, and those which may be caused more through childhood illnesses experienced prior to, or at the time of initial reading education e.g., Otitis Media (glue ear).

A child who has suffered intermittent hearing loss throughout the preschool years is at greater risk of experiencing later learning disabilities, especially in the language areas (Eimas & Kavanagh, 1986). Whilst glue ear may lead to dysfunctional auditory perception it also has other implications e.g., the child may also have experienced frequent school absenteeism due to the illness, thus interrupting his/her early teaching, or the primary hearing loss may have meant a decrease in exposure to auditory stimuli and subsequent learning opportunities rather than a more complex deficit being experienced in the discriminative areas i.e., whilst discriminative abilities may remain intact, the perceived stimuli are decreased. The correct identification of the possible cause of a problem at least assists in correct remediation procedures being put into place. In the example given, this would require a decision to be made regarding intubation to correct a primary auditory dysfunction, or some remediation being initiated in the auditory perceptual areas.

The ability to read allows the child to participate in other learning experiences and social situations both within and outside the schooling and academic environment. The importance of identifying possible contributing factors to the failure of reading acquisition is obvious when one considers the handicaps experienced by a child who suffers any degree of reading difficulties. Social withdrawal and loss of self esteem are only too often the result of continuing exposure to failure (Rourke, 1988). The longterm implications of this are obvious when one considers the plight of the non reader in our highly literate world. For example, in her summary of the results and recommendations of the ACLD (Association for Children with Learning Disabilities) R & D Project, Crawford (1981) stated that the research results showed learning disabled adolescents reported a significantly higher frequency of violent acts. Related to this, research has shown that a substantial proportion of official delinquents are handicapped with a learning disability (Cannon and Compton, 1980). Included in these populations labelled as "learning disabled" are a subgroup who suffer reading disabilities specifically. To provide these individuals with opportunities for early identification of their deficits (through auditory perceptual assessments, for example), as well as an education which recognised their disabilities and catered appropriately for their individual needs from an early age would be a great step forward in our quest to provide more than treatments which merely serve as the ambulance at the bottom of the hill.

MacGinitie (1967) commented on the apparent lack of emphasis in early childhood education, at that time, on the auditory perceptual area. He saw the lack of attention to the auditory aspects of reading as having received insufficient attention from researchers, (Richie & Aten, 1976). Working on the proposal of Russell and Fea (1963), MacGinitie speculated that this situation could have arisen due to the apparently more obvious need for visual perception in the reading process. After all, reading without the obvious use of auditory perceptual skills is possible, whereas reading without visual perception is a contradiction in terms. As Birch and Belmont (1964a) later emphasised the necessity for efficiently functioning intermodal processing between the visual and the auditory modalities, for successful reading, the implications of one inefficiently working area on the other, cannot be ignored. It would appear detrimental therefore, for an early reading programme to work only on the one modality, usually visual, whilst ignoring or taking for granted, the efficient functioning of the other, - the auditory. An appreciation of the complimentary role of both modalities is to be encouraged.

Also, it should not be ignored that primarily children learn to speak through hearing sounds around them. The world is an extremely auditorily based environment for the young infant who is not yet mobile. Whilst later motor development allows for exploration and seeking behaviour, an immobile infant relies heavily on his/her auditory sense to comprehend the world around him/her. At school age, this finely tuned sense should not be ignored when the child is presented with the written text. Visual memory and discrimination are of course necessary for reading skill acquisition, but teaching and training in this area should not be to the detriment of attention also being paid to the auditory modality.

The importance of auditory processes in the mastery of reading skills was emphasised by Flower (1968). He advocated a thorough assessment of a child's auditory processing and skills in any investigation of reading problems. The specific auditory processes which he identified were i) auditory sensitivity (ability to hear auditory signals at appropriate levels of loudness), ii) auditory attending (ability to discriminate and select relevant stimuli from a background of irrelevant stimuli), iii) auditory discrimination (ability to identify a given sound in a sequence of sounds), iv) auditory memory (ability to retain the elements of presented stimuli in correct sequence, as well as the amount of material retained), v) auditory integration (the ability to synthesize elements into meaningful oral signs), and vi) auditory-visual integration (ability to match aurally presented material to visual or graphic representations of that material). Whilst acknowledging the importance of each of these factors and the role each may play in contributing to possible reading deficits experienced by a child, Flower advocated more of a hierarchical approach to their evaluation than that which was used in more traditional direct observational approaches. He encouraged an appreciation of the fact that within the hierarchy of language skills, each level's achievements are subserved by those mastered at earlier levels. A major advantage of Flower's more structured approach is the greater ease with which assessment findings may be translated into the child's educational setting. Appropriate strategies can be put into place to aid the child in acquiring those skills which are found to be lacking, or extend and encourage those skills which are beneficial to reading acquisition. Flower's proposals regarding the inter-relatedness of skills concurs with the earlier work of Frostig (1963) who stated that visual perceptual skills also were inter-related and complex rather than independent and simple.

The valuable role of auditory perceptual assessments in the early identification of children "at risk" of possible subsequent reading disabilities cannot be denied. Not only can such assessments provide another avenue through which assistance can be given but they also allow for the early identification of such children i.e., before school age. The importance of the preschool years for remediation of these problematic areas means the child need not enter school already disadvantaged if he/she is given opportunities to strengthen dyfunctional areas during the early formative years

(II) THE IMPLICATIONS OF DYSFUNCTIONAL AUDITORY PERCEPTUAL SKILLS ON LANGUAGE LEARNING.

Eisenson (1966) identified four functions which he considered to be involved in language learning. These were:

> a). The capacity to receive stimuli that are produced in sequential order. b). The capacity to hold the stimuli in mind,to hold the sequential impression, so that its components may be integrated into some pattern. c). The capacity to scan the pattern from within so that it may be compared with other impressions or other remembered patterns. d). The capacity to respond differentially, meaningfully, to the perceptual impression.
>
> (p.23)

Generally, these four stages relate to the processes of a) intake, b) integration, c) comprehension, and d) feedback which gives information as to the appropriateness of the response. Varying levels of ability or impairment in each, or all, of these contributory factors may lead to problems in acquiring language skills, including reading. Eisenson discussed the implications of perceptual dysfunctions on subsequent language development, specifically in aphasic children and autistic children. As well as these two groups, which show more severe degrees of perceptual dysfunctions, there are those to whom Eisenson referred as also experiencing communication and educational handicaps but to a lesser degree. This group (maybe as many as 10% of the preschool and school age populations) was referred to as having "Specific Learning Disabilities". These individuals are considered to suffer some degree of central nervous system dysfunction, or "brain difference" as Eisenson preferred to rename it, and are subsequently hindered in their normal language development due to perceptual dysfunctions. Evidence of this is seen in the fact that, despite normal or above intellectual ability, these children evidence varying degrees of educational deficits in the language areas. Dysfunctions in perceptual skills may therefore be seen to lead to performance deficits on a continuum, from mild to severe.

In a study designed to investigate the auditory perceptual differences between a group of "poor" readers and a group of "good" readers, Lyness (1968) found the following auditory perceptual factors to be significant in making the distinction: i) memory, ii) constancy, iii) figure-ground (presumably of an auditory nature) iv) temporal discrimination, and v) synthesis. Compensation for auditory deficits in these subtests was found to be increasingly difficult as the number of defective abilities grew. The "poor" readers failed at least 3 or 4 subtests whereas the "good" readers did not fail more than one. Lyness's study provided more evidence of the necessity for intact and efficient auditory perceptual skills for the acquisition of reading. She also pointed out the benefits of being able to assess the auditory areas to identify a child's strengths and weaknesses and implement appropriate teaching programmes from an early age.

Schonell (1961) considered that the tasks of saying and listening helped in the assimilation of the "auditory elements" of words. In other words, he considered the processing involved in the saying and listening tasks to be pertinent to the efficient and effective acquisition of reading skills. He considered the following to be fundamental to good speech and reading, - i) auditory discrimination, ii) auditory memory, and iii) sequencing abilities. Presumably, investigating and identifying possible deficits in these areas could be used to assess the likelihood of future reading difficulties, with "poor" readers showing deficits in performance over "good" readers.

In 1970, Flynn and Byrne investigated this with a study of the auditory abilities (discrimination, memory and blending) in a selected group of advanced and retarded third-grade (approximately 8 years old) readers. They hypothesised that the two groups would perform significantly differently on these auditory tasks with the retarded readers showing inferior performance. An additional variable, that of socioeconomic environment, was also considered as an influential factor, with the hypothesis being that the low socio-economic home environment (or "inadequate learning environment" as they called it) would not be conducive to the development of auditory perceptual abilities in the child and therefore be detrimental to his/her subsequent reading achievement. An extensive battery of nine assessments was administered, measuring sound blending, auditory discrimination, auditory-vocal sequencing, pitch perception, and a screening test of articulation. Results showed that the tests which required blending of phonemes and syllables, and discrimination between pairs of words, nonsense syllables and musical pitches, yielded highly significant differences in performance between the two groups. Contrary to the findings of other researchers in the area however, socioeconomic environment alone was not found to affect auditory abilities. A positive relationship between IQ and reading achievement was noted, with the advanced readers being more than one standard deviation above the retarded readers, on verbal, non-verbal and full scale IQ, regardless of socioeconomic environment. This in itself is an interesting factor to consider. The question which needs to asked is whether or not Flynn and Byrne would have received the same results had they controlled the IQ variable. In other words, to what degree were the differences in performance between the two groups attributable to intellectual differences regardless of any concomitant auditory perceptual dysfunctions? As reported by Flynn and Byrne, however, their research supported the idea that reading retarded children differ from normal-achieving readers in their abilities on auditory tasks. As such, they encouraged the evaluation of auditory abilities so that appropriate extension programmes could be implemented for identified "at risk" children.

In 1978, Bradley and Bryant compared a group of older poor readers with a group of younger normal-achieving readers. The mean age of the latter group was 6 years 10 months whereas that of the older poor readers was 10 years 4 months. The poor readers were all of normal intelligence but 18 months or more behind the average reading skill for their age. The reading abilities of the two groups were approximately equal.

Bradley and Bryant's experimental design differed from the majority of other studies in the area in which the two groups being compared differed only on their reading abilities, but were similar in age and intellectual ability. Bradley and Bryant proposed that their design minimised the likelihood that the differences in reading abilities could be attributed largely to differences in experience and exposure to reading. Despite obvious age differences between the two groups (the older poorer readers being an average of 3 years 6 months older than the younger readers), and the concomitant added exposure the older children would have had during their extra years of schooling, their reading levels were nevertheless equivalent. It was proposed therefore that if both groups had reached the same reading level but the older children performed more poorly on perceptual tasks (despite an increased exposure to reading material due to their older age), it was not logical to place blame on a lesser exposure to reading material. Bradley and Bryant found that the older poor readers performed significantly poorer on tasks requiring them to perceive the differences in the sounds of presented words. Subjects were required to pick the odd one out in series of presented words where one differed either in the initial , middle or end phoneme. It was found that the older poor readers had difficulty in organising sounds. Their performance on these tasks was inferior to the younger normal-achieving readers, despite an obvious age advantage as well as higher intellectual levels. The older poor readers were at a particular disadvantage during the task requiring perception of the initial phoneme, as opposed to the middle or final phoneme. Bradley and Bryant suggested that this finding in particular deserved further investigation in ascertaining its relationship to the reading and writing problems often experienced. The overall finding of Bradley and Bryant's work supported their hypothesis that children who experience deficits in their reading abilities show difficulties with the categorisation of sounds.

In 1986, Nix and Shapiro administered a battery of auditory perceptual processing tasks to a mixed group of 70 Canadian school children, including those involved in reading assistance programmes. Their results suggested that auditory perceptual processing problems were evident to a significantly greater extent in the reading disabled population. Significant differences in performance were found on tasks requiring phonemic analysis and synthesis, the repetition of digits in reverse order (a task requiring not merely auditory memory but also manipulation of material held in memory), the phonemic syllabification of words, and memory for related words. Interestingly, no significant between-group difference was found in the performance of the WISC-R digits forward subtest, whereas performance differences on the digits backwards task were found. Perhaps therefore focus should be on the <u>processing</u> of information , and not merely pure memory training. The digits forward test requires purely a repetition of auditorily presented material, relying on auditory memory recall. The digits backwards test, however, requires not only that the material be received auditorily but also that it be held in memory, manipulated, and then given in a reverse order. Nix and Shapiro emphasised the importance of assessing auditory perceptual <u>processing</u> skills rather than just auditory acuity as is often the case. Problems may occur when a child is required to manipulate the information in memory store. Early identification of children with significant processing deficits would obviously be beneficial. This study provides more evidence of the necessity for an efficiently functioning intermodal processing ability i.e., visual to auditory, and vice versa, for the acquisition of satisfactory reading skills.

(III) THE ROLE OF VISUAL-AUDITORY INTERMODAL PROCESSING.

Using a population of third grade boys (mean age of 8 years 9 months), Rudnick, Sterritt & Flax (1967) attempted to investigate further the relationship between perceptual tests and reading achievement. Subjects were administered three different perceptual tasks which required attending to i) auditory-temporal rhythm patterns via earphones (in which the subject listened to an auditory dot pattern and then matched what he had heard to one of three printed dot patterns), ii) a purely visual stimulus requiring a match to be made between a visual-temporal stimulus (blinking light) and visual-spatial (printed dot) patterns, and iii) pencil-tap stimulus which involved both auditory and visual cues (developed by Birch and Belmont in 1964). In an earlier study in 1966, Sterritt & Rudnick had used a population of fourth grade boys in a similar experimental design in another attempt to identify significant independent predictors of reading scores.

The results from both studies indicated that, with an increase in age, visual perceptual abilities decline in importance as indicators, whereas general intelligence and auditory and/or inter-modal perceptual abilities increase in importance as reading score predictors. This can be said to be true between the third and the fourth grade age increase, at least. These findings were similar in some ways to those of Birch and Belmont (1964a) who had used a population of bright normal, middle class children. The children's performances on tasks of auditory-visual integration improved from the kindergarten age group (mean age 5 years 8 months) to the Grade 6 age group (mean age 11 years 6 months). By the second grade level (mean age 7 years 7 months), accuracy in performance had reached 80%. Improvement from that age on was slower but steady, with a less steep improvement slope being evident during the later year, resulting in smaller accretions approaching an asymptote. Also, as the importance of visual perceptual abilities in relation to individual differences in reading ability was shown to decrease in importance with increasing age, auditory perceptual abilities and the ability to transpose between the auditory and visual modalities increased in importance. There was a high correlation between auditory-visual integrative performance and reading skills in the children. If that integrative ability was dysfunctional at all, then the acquisition of reading skills was obviously detrimentally affected. As a summary, Birch and Belmont suggested that,

> The acquisition of auditory-visual integration may be viewed as learning to learn to read, and may well represent a primary competence requisite to the acquisition of this skill.
>
> (p.303)

Using a task requiring a match to be made between an auditorily presented tapped rhythm pattern and a graphically displayed visual array, Birch and Belmont (1964b) again concluded that a deficit in inter- and intramodal transfer was implicated in being causal to reading failure. However, Zurif & Carson (1970) later criticised Birch & Belmont's work as there was no control experiment done i.e., they stated that Birch & Belmont may have got their results because the "dyslexic children" (as Zurif and Carson called them) tested were unable initially to make use of temporal information in the auditory stimuli. Rather than the assumed inefficiencies in intra-modal processing, this inefficient perception would have influenced the results detrimentally. As an alternative explanation, Zurif & Carson emphasised this inefficiency in the perception of temporal sequences, rather than the subsequent intra-modal processing disturbances, as being causally related to reading disabilities.

Rudel and Denckla (1976) stated that the necessity for intermodal processing could be appreciated when data from brain damaged patients was considered. They stated that by considering the negative evidence, i.e., infering from what was missing to what must normally be necessary, it was possible to appreciate that those acquired lesions of the nervous system which reportedly disrupted the process of reading, interrupted anatomical pathways which travelled from the visual to the language areas of the brain. The fact that these pathways mature relatively late and at different rates in the human brain, may indicate some possible reasons for individual differences in reading achievement.

The increased importance of general intelligence to reading skills, at later ages, can be understood better when it is considered that whereas auditory-visual integration appears to be of primary importance to reading skills at an early age, intelligence governs the <u>extent</u> to which these skills may be acquired. Birch and Belmont's statement that an understanding of intermodal relations would assist in our quest for an increased knowledge of the mechanisms underlying reading readiness as well as other skill acquisition, cannot be over-emphasised. As a basis for further reading skill acquisition, intermodal processing is fundamental to that which intelligence can later develop.

The findings regarding the age-related increased importance of auditory perceptual skills to reading skill acquisition have received support from the research of Myklebust (1960) in which deaf children, between the period of age 9 to 15 years, were shown to experience progressive relative retardation in their reading vocabularies. Whilst initial reading skill acquisition by the deaf children may have been considered to have been commensurate with their unimpaired peers, later relative retardation in reading vocabularies by the auditorily impaired students can be understood in light of the known, and accepted, necessity for an efficient auditory processing ability in this skill area.

(IV) AUDITORY PERCEPTUAL ABILITIES AMONGST "EXCEPTIONAL" POPULATIONS, - THE ABILITY TO ORDER TEMPORAL MATERIAL.

Numerous studies have investigated the auditory perceptual abilities of many different "exceptional" populations. (The term "exceptional", in this case, is used as a global reference term to accommodate the heterogeneity of populations used in studies). For example, disturbances in auditory perception have been noted among cerebral palsied children (Ingram, 1960), and aphasic children (Furth & Pufall, 1966). The research with the aphasic children showed their performances to be significantly poorer than the comparison group of hearing-impaired children on a test of auditory sequencing. Aten and Davis (1968) noted that although research with children who suffered some degree of cerebral dysfunction was not plentiful there was, however, evidence to suggest that such children were prone to errors of omission, reversal and/or distortion on auditorily presented tasks.

Aten and Davis investigated the auditory-oral modalities of a group of 21 children with mild or minimal cerebral dysfunction. These diagnoses were made by paediatric neurologists and were based on a variety of neurological signs e.g., abnormal EEG, seizures or propensity to seizures thus requiring anti-convulsant medications, head trauma, bilateral hematomas, mild sensory deficits. Eighteen of these children were in special classes for neurologically handicapped children whilst the other three attended classes for aphasic children. All children were aged between 6 years 7 months and 10 years 4 months (mean age = 8.0 years) and were within or above the average range on standard psychometric measures of intellectual ability (mean IQ = 106). This group of 21 children was compared with a control group of 21 neurologically normal children with an age range of 6 years 8 months to 9 years 9 months (mean age = 8.3 years) and similar intellectual abilities to the experimental group of neurologically impaired children (mean IQ = 108). Each group comprised 13 boys and 8 girls. The results of the investigation showed that as well as inferior performance on tasks involving serial noun span, multisyllabic word repetition, scrambled sentence arrangement, and oral sequence accuracy, the neurologically impaired children differed significantly from their control peers (matched for age, IQ, sex, and family income) in their ability to order temporally when tested on rhythm and duration tests i.e., neurological impairment hindered the ability to order temporally with the result that those children with cerebral dysfunctions showed inferior performance when dealing with sequential information. The two Rhythmic Puretone Sequence tests which were involved in Aten & Davis's research allowed for a distinction to be drawn between those children who had difficulties in the perception of rhythmic patterns and those who did not experience difficulties in the perceptive area but did so in the ability to orally reproduce that which was presented. In other words, it was possible to distinguish between those individuals who had perceptive difficulties and those who had performance difficulties. This is an important distinction to make and Aten and Davis advised that future research studies would do well to take note of the response methods required of their subjects. Possible differences between auditory-perceptual and auditory-visual associations need to be recognised when one is aiming to identify problematic areas.

Interestingly, this deficit in temporal ordering amongst neurologically impaired children had been noted by a prominent researcher decades beforehand. As early as 1937, Orton had acknowledged that it was in the recall of sounds in correct temporal sequence that children with speech and reading problems experienced difficulties. The problem in correctly ordering acoustic events appeared to be a hallmark of such children.

This was noted again by Atterbury (1985) in a summary report of three different projects, spanning over three years. The projects, which investigated the differences in rhythm pattern perception and performance in a normal-achieving and learning disabled population of 7 to 9 year olds, reported finding differences between the two groups in rhythm pattern production. As earlier research by Lienhard (1976) had acknowledged that intelligence was an influential factor in determining rhythm perception in children (at least amongst the institutionalised retarded population with which he was working) it was to Atterbury's credit that the IQ variable was controlled in her research. Both the normal achieving and learning disabled groups were of normal intellectual ability, however the learning disabled children showed varying degrees of learning deficits. Differences between the performance levels of the groups therefore could not be attributed to lack of intellectual ability. In the hope of working with a more homogeneous group of learning disabled children, Atterbury restricted her experimental group to only those with reading deficits.

Interestingly, Atterbury found that while the ability to discriminate between same/different rhythm patterns was similar for both the reading disabled and the normal achieving group, the disabled readers performed clapped rhythm patterns more poorly that their normal-reading peers. A distinction between perceptual abilities and performance abilities was therefore made. Whilst auditory discrimination skills were similar in both groups, the performance task (i.e., the clapping) was performed poorer by the learning disabled readers. This finding is interesting in light of previous research which implies differences between "normals" and learning disabled children in discrimination abilities. One wonders if the results of some earlier pieces of research may have been similar had this distinction between discrimination and performance been made more specificially. Were the discriminative abilities of the research subjects assessed through their performances alone?

Nevertheless, like other studies in this area, one implication of Atterbury's findings was that "exceptional" learners (as she called them) need to be assessed on their input, integrative and output abilities prior to placement in normal classes, especially for music education. The process of learning music may be quite different for both groups but an understanding of why those differences occur requires investigation into modes of rhythmic input affecting discrimination, and modes of output affecting performance ability. An understanding of differing information processing abilities for both the normal and retarded readers has implications in music education and other academic areas as well. For example, is the teaching of syllabification, and breaking a word up into its "beats", an appropriate teaching method if a child with a reading disability is unable to perceive and/or copy the differences in stimuli presented in this rhythmical way? Also, if that child appears unable to syllabify, is it because he/she is unable to i) comprehend the task, ii) discriminate between the auditorily presented stimuli, or iii) satisfactorily perform in the required fashion of echo or join-in style clapping?

Questions such as these must remain inconclusively answered in light of the current limitations of our knowledge in this area. It is ethically and professionally responsible to remain open to alternative explanations and proposals in such areas, and to be aware of the implications these ideas have in practical teaching situations. In general it would appear that the ability to accurately perceive temporal material is an area in which reading disabled individuals experience difficulties. The effects of varying modes of performance e.g., join-in versus echo clapping, as used by Atterbury, may be influential in the accuracy of the task. An appreciation of both the input and the output modes when evaluating task accuracy is obviously to be recommended.

(V) APPRECIATING THE STAGES AT WHICH DYSFUNCTIONAL PROCESSSING MAY OCCUR.

Atterbury's work captures the essence of that with which many researchers have grappled i.e., in which of the input, integration, and output steps does the reading disabled child show significant differences from his/her normal achieving peers? Only through thorough analysis of each step can we hope to further understand the stage at which dysfunctional processing occurs, (Tallal, 1980). Atterbury's work suggests that it is not in the auditory discrimination areas that learning disabled children differ from their normal achieving peers, but in the performance tasks. Her research results have implications not only for music education, to which the direct application of her work is obvious, but also in the language area as a whole. If it can be ascertained in which particular stage learning disabled children experience processing difficulties then a great deal may be learned about areas which require remediation.

The generalisation of findings from the musical education area to other academic areas may provide the basis of a theoretical framework on which future research may build. If it is true that reading disabled children differ from their normal achieving peers in their performance of auditorily presented rhythm patterns but not in their discrimination, the influences of differing modes of output need to be investigated. If, however, the differences in performance between the two groups lie at the earlier stage of discrimination (i.e., a dysfunction in auditory perception rather than motor skill performance), an investigation of perceptual differences would seem appropriate. Overall, an understanding of the processes involved is ultimate. Whereas the differences in reading achievement between the two groups is accepted, an understanding of the underlying causes of those differences is our aim.

Swanson's (1987) investigation into the encoding, storage and retrieval processes of learning disabled readers is a clear example of the challenge presented to researchers. By using verbal dichotic listening tests he compared the free recall and cued recall abilities of a group of skilled readers and learning disabled readers. He found a performance difference between the two groups on tasks of cued recall, with the disabled readers performing less well. Further analysis of his results showed these poor readers to have inferior memory traces compared to the skilled readers. Swanson suggested that the disabled readers experienced attentional difficulties during interhemispheric processing and this detrimentally affected the formation of memory and subsequent retrieval ability. As his earlier research showed, however, (Swanson, 1986), the allocation of attention resources is task dependent and may alter depending on the retrieval commands given. With this in mind, therefore, some caution must be exercised when making any conclusions. As an answer to the question of encoding, storage or retrieval deficits leading to learning disabilities, Swanson concluded that in his view the cause of the disabilities was a storage deficit. (Similar proposals were forwarded by Beale, Matthew, Oliver & Corballis, 1987).

Whilst dysfunctional processing may occur at any of the afore- mentioned stages, the possibility of memory differences between learning disabled and non learning disabled children must be considered. Memory storage, manipulation, or retrieval capabilities may vary between the groups thus detrimentally influencing subsequent stages of processing.

(VI) THE ROLE OF MEMORY

In a study designed to investigate both auditory-visual integration and the perceptual and memory processes underlying this integrative process, Badian (1977) compared the performances of a group of 30 retarded readers with those of a group of 30 normal readers. There were no significant differences between the groups with regard to sex, age or IQ. Badian found that the two groups differed significantly on tasks requiring auditory memory skills as well as integrative skills. The retarded readers performed less well than the normal readers on all tasks demanding short-term auditory memory and they performed increasingly poorer than their adequately reading peers as the memory demands of a task increased. The reverse of this was also true, in that the retarded readers experienced little difficulty with nonverbal auditory-visual integration when the memory demands of the task were minimal. The integrative performance ability of both groups was related to the accuracy of memory for the initial auditory stimuli.

Badian's findings supported the notion that a memory impairment for temporal sequential stimuli, possibly leading to inferior auditory-visual integration, is contributory to some degree to the problems experienced by retarded readers (Corkin, 1974). She suggested that such impairment, rather than an impairment in the intermodal integrative transfer per se, would more than likely lead to the inferior performance of reading retarded children on integrative tasks. This does not remove the intermodal processing step wholly from the "limelight" so to speak, but rather identifies another stage which may be contributing to the dysfunctions of a reading disabled child.

Similar findings regarding the decreased auditory memory capacities of reading disabled children were reported by Richie and Aten (1976). In an attempt to investigate further the abilities of reading disabled children and non reading disabled children on tasks requiring retention and recall of serially presented stimuli, they compared the two groups on tasks demanding auditory retention of nonverbal stimuli e.g., rhythmic patterns, and verbal stimuli e.g., words, sentences and phonemes. Their 40 subjects (20 reading disabled and 20 non reading disabled) were all 9 years of age or above, with a minimum IQ of 90 (as assessed on the Peabody Picture Vocabulary Test), and had normal hearing. Significant differences were found between the performances of both groups on tests of rhythm and duration (as tested by the nonverbal subtests), with the reading disabled children showing inferior ability to retain the sequence of varied rhythmic and durational patterns. A deficiency in auditory retention of nonverbal sequential stimuli was noted to be related to reading disability. Similar results were found on the tests of retention of auditory verbal sequential stimuli. One of the implications of Richie & Aten's work is that the retention of auditory information plays a vital role in reading efficiency. As such, when a child presents with a reading disability, assessment of his/her auditory retention skills should be a standard requirement.

In summary, it would appear that the literature in the area appears to be largely in agreement that a relationship exists between auditory perceptual areas and reading achievement. It is important to acknowledge that despite continuing debate, specifically with regard to directional causality, recognition of the importance of satisfactory auditory perceptual skills for the success of language based tasks, especially reading, should not be denied. With an appreciation of the dilemmas faced by so many reading disabled adults in our highly literate world, the recognition of another avenue through which they may be identified provides hope for those who are yet to be caught in the "once a non-reader, always a non-reader" trap. Enthusiasm should be expressed especially when it is considered that such recognition could occur at an early age! Whilst visual perceptual skills are obviously a desirable pre-requisite for the acquisition of efficient reading skills, these should combine with satisfactory auditory perceptual abilities to enable optimal auditory-visual integration and subsequent satisfactory reading ability

B. MUSIC AND MUSIC THERAPY

Music has long been appreciated for its artistic and pleasurable qualities, but in more recent times its therapeutic and educational attributes have received greater attention. In 1957, Gilliland described music as an effective means for assisting in the improvement of a child's attention span and concentration, - specifically in those children suffering from learning disorders. Gilliland's foresight was well founded considering the more recently enjoyed increase in the popularity of using music as a therapeutic and educational tool. An appreciation of the components of music helps us in understanding the role each may play in learning as a whole.

(I) THE KODALY MUSIC SYSTEM

One practical application of the use of music and its components in a more general educational setting was seen with the introduction of the Kodaly system for teaching music in Hungary. This highly structured system was introduced not only for learning disabled children, or children who were specifically musically gifted, but for some areas of the general school population. It was an effort by Kodaly, and his contemporary composer Bartok, to lessen the gap between Hungarian folk traditions and other areas of education. Primarily, the system makes use of the rich availability of Hungarian folk melodies and songs. Music is incorporated into the child's life through nursery rhymes and folk songs, from the earliest age. Kindergarten age children become experienced in discriminating between high and low, loud and soft, and quick and slow. The development of rhythmical skills is emphasised from early levels and the awareness of rhythm patterns is encouraged and practised through movement. The combination of temporal and spatial skills is practised through a programme which provides opportunities for rhythmical structures to be recognised alongside comparable visual symbols e.g., symbols on a blackboard, or children standing at varying distances from one another, thus representing the relationships of beats in time. Children are given practice in matching the auditory and visual modalities through connecting the mediums of rhythm and pitch. Exposure to varying stimuli develops periods of concentration.

Kokas (1969) began research with the Kodaly music system in 1966, initially involving twenty 3 year old children who were drawn from a children's residential home setting and were involved in a rich and varied musical programme. This involved weekly singing lessons as well as daily singing games, combining to provide an environment constantly enriched with musical experiences. These children (the experimental group) were compared with a control group of 3 year old children, drawn from a comparable children's residential home setting, on a variety of musical tasks e.g., resinging of melodies and pitches, answering rhythmical passages with clapping or instruments, moving to various rhythms, ability in improvisation etc. Similar comparisons were made between a group of children in a normal home setting who attended special music lessons twice a week and another normal home setting group who were not provided with such experiences.

Developmental stages on the various tasks were noted through observations, and tests were used to examine readiness of observation (i.e., readiness to observe "same" and "different" in melodies etc. which is an important component in the Kodaly system) and readiness of motion. On observational tests, both the "children's home musical group" and the "normal home musical group" performed better than their comparative control groups on the most difficult tasks. The differences were not, however, statistically significant. One of the most interesting findings of the research amongst the older 6 to 8 year old children was a large between-group difference on tests of coordination, with the musical group showing superior performances.

Claims of subsequent improvements in reading, arithmetic and study habits in a normal school population were made after the introduction of the Kodaly system. Although the exact mechanisms of transfer were not completely understood, it became obvious that a generalised learning effect resulted subsequent to the introduction of the programme. Kokas noted that in 1969, over one hundred Hungarian schools had special music education courses. Improvements in sports achievements, art appreciation, as well as music abilities, in the children involved in the music education courses have all been attributed, to some degree, to the use of the Kodaly system. Proposals that the children showed psychological and somatic changes were evaluated by the administration of psychological tests, although Kokas makes no mention of specific tests in her paper. The author put some emphasis on the issue of developing the "children's personalities", specifically those children who suffered some degree of emotional disturbance.

In a later study, Hurwitz, Wolff, Bortnick & Kokas (1975) evaluated the effectiveness of the Kodaly system of music instruction on the spatial abilities, sequencing skills and academic achievements of a group of normal American, middle class children. Their study was designed to test the hypothesis also postulated by other research findings, i.e., emphasis on rhythm recognition and awareness in musical training at an early age is beneficial to the later development of sequencing behaviour and spatial functioning. It was also hypothesised that these benefits would extend beyond the musical setting and become apparent in other areas of academic performance e.g., reading. Hurwitz et al worked with two groups of 20 children, - 10 first grade boys and 10 first grade girls in each group. Neither group showed any degree of academic difficulties. The children in the experimental group received 40 minutes of Kodaly education from an experienced music instructor for five days per week. The second group of children, i.e., the control group, were matched for age, IQ, sex, social class, ordinal position in the family and academic standards, however they received no Kodaly classes. Both groups were assessed on measures of sensorimotor sequencing, verbal perceptual sequencing, and general verbal intelligence. Results showed that the experimental group performed significantly better than the controls on three out of the five sensorimotor tapping tasks, and four of the five spatial tasks. Interestingly, because of Hurwitz et al's and others' findings regarding the higher incidence of academic performance problems amongst males than females, an analysis of the results was also done between sexes. It was found that boys in the experimental group performed better than boys in the control group on three of the five sensorimotor tasks, two of the three verbal sequencing tasks, and three of the four spatial tasks. On the other hand, however, there were no significant differences in the performances of the control girls and the experimental girls on any of the tasks. It appeared that, in the areas of temporal and spatial cognitive activities the boys benefitted from the Kodaly programme whilst the girls received no such comparable benefit. The Kodaly system's usefulness in helping to compensate for initial differences in reading readiness between sexes is commended.

Initially the enthusiasm that such programmes evoke can only be encouraged as they provide another avenue through which education can extend the immediate environment of a child. However, it should be acknowledged that over-enthusiasm may also be detrimental as it allows a readily accepted view of the approach to evolve with little or no constructive criticism being encouraged. There is also the possibility of other systems being excluded due to the supposed overwhelming success of the one system in place. The Kodaly System obviously has many positive features but some questions must arise concerning the immediate claims of success the programme exalts with regard to sports achievement progress, and the degree to which "children's personalities" can be developed through this system. Obviously, a clearer understanding of the programmes limits of effectiveness and transference to other academic areas would be encouraged. Whilst an appreciation of the intricacies and contributing factors of musical experience would appear to be beneficial when assessing the role it is purported to play in the learning experience as a whole, it should not be considered that Music Therapy provides a panacea for reading or learning disabilities, but rather a useful and complementary adjunct to other educational areas.

(II) THE ROLE OF MUSIC THERAPY

The total experience of "Music" may be broken down into its components of pitch, intensity, timbre, and rhythm. The perception of rhythm in movement is seen as being important as it assists in combining and integrating the many modes of informational input which an individual may experience (Kallan, 1972).

It can be argued that rhythm is probably the most important function of all musical abilities. Without rhythm, there is no music as it is the rhythm which acts as the framework. A piece of music with identical pitch notation but with different rhythm patterns may be unrecognisable. The emotional effect of that piece of music may be dramatically altered. The dances of primitive peoples are obvious displays of strong rhythmical groupings, where pitch, melody and harmony are absent. These dances evoke both unconscious and organised displays of dancing and rhythmical movement. To some extent, rhythm is the link between movement and emotion.

Schomer (1973) noted that rhythm alone develops perceptual awareness whereas the other components of music are affectual experiences. As a child moves around in time, or to the rhythm of music, he/she is developing perceptive skills as well as an appreciation of spatial awareness. Body image and awareness are also developed during activities which require the child to "explore" his/her environment to the rhythm of the music. It is in the acceptance of the necessity to acquire auditory skills, and the recognition of the important role of musical experience, that the basis of Musical Therapy is found.

Schomer proposed a perceptual development programme for Music Therapists with an emphasis on encouraging both the affectual aspects (involving timbre, intensity and pitch) and the perceptual aspects (rhythm). He suggested that remediation initially may require the music therapist to move the child around his/her environment to the beat of music. The child then becomes more aware of his/her place in space, with an increasing realisation of his/her own senses also. These senses must "communicate" with each other so that the child can interpret what he/she is experiencing. By being allowed to observe and imitate the actions of others there is an increasing awareness of the similarities between self and others. The competent Music Therapist therefore allows the child to copy her/his actions. Moving in time to the music is observed, encouraged and imitated.

The next important stage, according to Schomer, is the progression from perceptual experience to the abstract i.e., "symbolisation". The use of abstract symbols results from an ability to categorise and to appreciate degrees of "sameness" and "difference". Schomer identified three different kinds of categorisation i.e., i) Affective, - the difference between pleasant and unpleasant experiences, ii) Functional, - an awareness that things in the physical world (e.g., space and time) have significance, or "meaning", and iii) Formal, - including nonverbal and verbal symbols which are, in general, more abstract than those in earlier stages. For this latter stage, Schomer gives the example of a nonverbal symbol which is interpreted into a meaning e.g., hearing the sound of a tune on the radio and identifying that tune with a particular commercial product. This stage involves the Music Therapist in helping the child to acquire language skills, as well as specialised skills in the field of music education.

The last stage of Schomer's programme is that of Creation. This is the reverse of the concrete to abstract stage, as it involves concrete performance. The Music Therapist encourages creativity in the child. Creativity, within this schema, may be seen as the product of a well-integrated mind.

When dealing with a child who experiences difficulties in his/her learning processes and development, Schomer sees the role of the Music Therapist as helping in the development of the child's mind from a "blooming buzzing confusion" (as he describes a child's awareness and state of consciousness at birth) into a state where the affectional and perceptual aspects are functional and complimentary. The use of music in such cases allows for the imagination to be stimulated also.

Roskam (1979) investigated the effectiveness of Music Therapy intervention on attempts to expand auditory perceptual and language skills of 36 (an undesirably low sample number, Roskam noted) learning disabled children. All children were aged between 6 years and 9 years and attended a public school as well as an educational psychology clinic (in the California University campus) because of their specific learning disorders. Each child was assigned randomly to one of three treatment groups, i) prescriptive music therapy, ii) language development activities, and iii) a combination of all these. Each group had 12 children and received one hour of activities twice weekly, for a period of three months. Pre-test and post-test measures were taken of ability in reading comprehension and recognition, spelling, nonverbal auditory awareness, and verbal auditory awareness. Parent and school reports were also obtained so other changes about the child during the three month period could be noted.

The highest mean difference between pre and post formal test scores was noted in the music therapy group, although an analysis of variance showed no statistically significant differences among the three groups. These results would appear to suggest the benefits of investigating further the value of music therapy as a treatment option, specifically with reading difficulties in which the biggest gains were noted. Although allocation to treatment groups was random, Roskam pointed out that the mean age for the music therapy group was 7 years 3 months whilst the mean ages for the other two groups was 8 years 5 months and 8 years 8 months. From a developmental viewpoint, it is possible that this age difference between groups may have been influential to some extent in gaining the achieved results. Two other variables which Roskam proposed as possibly influencing the results were i) parental attitudes to the use of music therapy, and ii) some inconsistencies in attendance at remedial sessions which were noted over the three groups. In fairness to Roskam it should be noted that such variables are not exclusively influential to this setting and would no doubt effect results in other research as well.

(III) THE LINKS BETWEEN MUSICAL AND READING ABILITIES

In two very recent studies, Barwick, Valentine, West and Wilding (1989) investigated the relationships between reading and music abilities. The research method they used allowed for the important and extremely influential extraneous variables of age and IQ to be partialled out. Their correlational studies looked at the relationships between aspects of musical ability and reading age. Although their work allowed for the extent of the relationship to be focussed on, it was not possible to determine a causal relationship. Nevertheless, the relationship between some musical tasks and reading skills was purported, with a clarification that the identification of different types of reading difficulty could aid in making this relationship clearer. In their first study, a total of 16 children (8 female and 8 male) were involved. The age range was from 7 years 6 months to 10 years 6 months, (mean age 9 years 2 months). Full scale IQ scores ranged from 86 to 141 (mean FSIQ110). All children were administered the Bentley Test of Musical Abilities (1966) as well as the Digit Span subtest from the British Ability Scales and the Schonell Graded Word Reading Test. In the second study, 50 children were tested, - 21 male and 29 female. The age range was from 6 years 6 months to 11 years 5 months (mean age 8 years 10 months). Full Scale IQ scores ranged from 81 to 132, (mean FSIQ 107). Barwick et al's results from both studies showed positive relationships between tonal memory and reading age, and between reading age and chord analysis. Atterbury's (1985) results regarding the tonal memory tests received some confirmation as well. Obviously, some skills and abilities are shared by both reading and music tasks. The direction of any causal relationship cannot be determined although some interesting possibilities were proposed by Barwick et al. They stated,

> ... the possibility remains that mastery of reading may indirectly aid performance of the musical tasks because it requires development of the relevant skills (or, conversely, musical training may aid the development of reading skills), rather than some pre existing efficiency in the underlying processing systems affecting skill in both reading and the musical tasks. (p. 256)

A beneficial repercussion of such findings would be an ability to predict reading progress from earlier performance on tasks of musical ability. Again, the early identification of "at risk" children is an obvious and desirable aim.

C. THE NEUROLOGY OF READING (DIS)ABILITIES, AUDITORY PERCEPTION, MUSICAL PERCEPTION, AND RHYTHM.

(I) READING DISABILITIES

As early as the 1920s, Orton proposed that poorly established laterality was associated with reading difficulties. Since then there has been considerable and ongoing debate regarding the role of laterality, and mixed cerebral dominance in the area of reading disabilities. Do findings in this area indicate that assessments of lateralisation have any diagnostic or predictive value? The majority of researchers agree that children who evidence some degree of reading disability demonstrate different patterns in their cerebral functioning. More specifically, a higher percentage of "mixed" or "confused" laterality is found amongst reading disabled children. The greater incidence of left handedness (indicating right, non-language hemisphere dominance in the majority of cases) amongst dyslexic children tends to perpetuate the argument regarding the causal relationship between weak-lateral preference (implicating incomplete cerebral dominance) and reading disabilities. This argument does not, however, explain those dyslexics who are fully right handed and those left handed individuals who are not dyslexic (Zangwill, 1962).

Laterality preference may change throughout a child's early years. Periods of mixed dominance, or ambilaterality, may be followed by periods of obvious right or left preference. As well as laterality preference, laterality awareness is also important i.e., the ability to recognise left and right on others. Birch and Belmont (1963) found a significant increase in the occurrence of defective laterality awareness in disabled readers.

With regard to the arguments proposed concerning possible relationships between cerebral dominance and reading ability, Isom (1968) warned against any explanation of reading disabilities which oversimplified the concept of cerebral dominance. Whilst oversimplification may not be our goal, it may nevertheless be the result of our attempts to explain that which, to date, has eluded conclusive results.

Another consideration in the explanation for reading difficulties lies in the area of maturational delay. Differing rates of maturation between males and females may help in the explanation of why there are more males than females in the dyslexic or specifically learning disabled categories. (The most commonly cited ratios range from 3:1 - 4:1). These maturational differences apparently show by the age of 5 or 6 years, (Whitsell, 1968), and of course coincide with the period of time at which the majority of children are first presented with the written text. Further maturational or developmental delays, for any reason, compound these individual differences.

As part on an extensive epidemiological study on the Isle of Wight, Rutter, Graham and Yule (1970) investigated possible relationships between varying neurological disorders and reading retardation. Following stringent screening and neurological assessment, the children were assigned to either of three mutually exclusive groups, i) uncomplicated epilepsy, ii) cerebral palsy, or iii) "other" brain disorders. It was found that amongst these children, 26% were designated as having some degree of reading retardation, whilst only 6.8% of the control group were classified as such. These findings have added in some way to the move towards attributing a large range of development problems to "minimal brain dysfunction" (MBD). MBD is used as a global term encompassing a heterogeneous group of conditions. Whilst some researchers have chosen to accept this model in their explanations of reading deficits/disorders/dysfunctions, others see it as an imprecise term only adding to the confusion in an already ill-defined area. Aman and Singh (1983) see it as a circular argument with Minimal Brain Damage being used to explain differing educational and behavioural anomalies, while at the same time relying upon the existence of these anomalies for its very diagnosis.

The literature concerning the degree to which reading disabilities may be attributed to lack of cerebral dominance, either through MBD or maturational delay remains inconclusive. Both sides of the debate have positive factors but neither is able to explain the area adequately so as to rule out completely the proposal of the other. Perhaps it should merely be acknowledged that, regardless of origin, some degree of Minimal Brain Dysfunction (MBD) should be accepted as the possible cause of reading disabilities. As a global term, the concept of MBD alerts us to the problem area without narrowing the concept to an argument of dominance versus maturation.

It is acknowledged that other possible causes may also be postulated and it is a hope that future research in the area will help in the investigation of these. The role of psychological factors, social influences and possible physical determinants should at least be acknowledged.

(II) AUDITORY PERCEPTION

Through the use and evaluation of dichotic listening experiments (involving the presentation of auditory stimuli simultaneously to both ears) it is possible to observe the asymmetry of brain function. It is widely acknowledged that the differing perception of verbal (e.g., digits and nonsense syllables) and non-verbal (e.g., melodic patterns and environmental sounds) stimuli reflects this functional asymmetry of the brain. The superior right ear scores for perception of verbal stimuli reflects the left hemisphere specialisation for language functions. Developmental studies suggest that a right ear advantage (left hemisphere dominance) for verbal input appears to be established by age 5-6 years. (Knox & Kimura, 1970; Berlin, Hughes, Lowe-Bell, & Berlin, 1973). Conversely, the superior scores of left ear perception for melodic patterns, reflect the specialisation of the right hemisphere for non-verbal stimuli. In accordance with this, defects of non-verbal auditory perception tend to be associated with lesions of the right temporal lobe (Lezak, 1983).

Knox and Kimura (1970) investigated the ages at which the brain's asymmetrical patterns first appear in children. Although Kimura's earlier research had shown that right ear superiority for verbal stimuli (i.e., digits) appeared no later than age 6 years in both sexes, Knox and Kimura's research in 1970 found boys had a performance superior to girls, when identifying nonverbal environmental sounds. These environmental sounds included sounds equally familiar to both sexes, e.g., coughing, and teeth brushing, so any explanation which proposed a superior recognition on the basis of greater familiarity by the boys was not possible. Knox and Kimura did not believe that the males' superior performance could be attributable to a superior labelling ability either, because the girls surpassed the boys in their use of expressive language. What answer was there to explain these sex differences in the auditory perception of nonverbal stimuli? Perhaps the answer lay in an appreciation of the <u>patterning</u> of these superior performances by males and females, with both sexes performing better on some tasks and not as well on others. Satisfactory performance on visuo-spatial tasks has been shown to be dependent on an adequately functioning right hemisphere, as is the perception of environmental sounds. Since males tend to perform better than females on tasks requiring these skills (i.e., spatial abilities, and non-verbal auditory perception), and both are subserved predominantly by the right hemisphere, it would seem that possibly right hemispheric function differs between the sexes i.e., there is a difference in hempisheric neural functioning, between the sexes.

In an investigation which looked at the differences in cerebral dominance between a group of normal readers and a group of dyslexics, Zurif and Carson (1970) administered a number of perceptual tasks and found that there were significant differences between the performances of the two groups. All the subjects were boys at grade 4 level i.e., approximately 9 years of age. On the dichotic listening tasks, when compared to the normal readers who showed a right ear advantage (i.e., left hemisphere), the dyslexics tended to be better in reporting material presented to the left ear (right hemisphere). In other words, instead of a dominant left hemisphere for the processing of auditory stimuli, the dyslexics showed a preference for right hemispheric processing. Localisation of language functions to the left hemisphere did not appear to be complete i.e., some degree of maturational delay was implicated resulting in incomplete cerebral dominance.

Mamen (1987) compared a group of kindergarten age fluent readers with a) chronological age controls and b) reading level controls, on tasks of dichotic listening, finger tapping, and nonverbal intersensory tasks. Due to the dearth of similar research using young fluent readers, no specific hypotheses were formulated prior to the assessments being administered. The investigation was primarily to examine whether the early fluent readers would show laterality patterns similar to, or different from, their reading level, or chronological age, controls. Differences of performance on these three tasks were found between the fluent readers group and chronological age controls, but not between the fluent readers group and their older reading level controls.

The implications of Mamen's results suggest qualitative, rather than simply quantitative differences in laterality patterns of young fluent readers over their chronological age controls. If the differences were purely maturational in nature, it would be expected that the differences would be purely quantitative. The young fluent readers were characterised by greater bilaterality of fine motor skills (evident on the finger-tapping tasks), good intersensory skills (evident on tasks requiring matching between auditorily presented stimuli and visually displayed choices) and a slightly increased right ear advantage for verbally related material.

As previously stated, the perception of auditorily presented stimuli allows us to witness the asymmetry of brain function. Presumably, the right ear (left hemisphere) reflects superior performance with the perception of verbal input e.g., digits, whilst the left ear (right hemisphere) evidences superior performance with nonverbal input e.g., melodic patterns. Research has shown this pattern to be largely established by 5-6 years of age, however sex differences have been noted in performances on certain tasks. Overall, it would seem that differences in neural functioning between the sexes lead to females enjoying superior performance on language oriented tasks (involving predominantly left hemisphere) whilst males show superior performances on tasks involving visuo-spatial abilities as well as perception of nonverbal environmental sounds (involving right hemisphere).

Evidence supporting this pattern of neuropsychological functioning was also found by Harness, Epstein & Gordon (1984). Of the 105 students (most of whom were young adolescent males) who attended a clinic for reading disabilities, 105 performed better that the normative group on tests associated with right hemisphere functioning. With regard to similar findings, Sobotowicz, Evans & Laughlin (1987) postulated that learning disabled individuals may learn to maximise development of functioning in the right hemisphere so as to compensate for inherent deficiences in the processing capabilities of the left hemisphere.

Research investigating the performances of normal and poor readers on auditory perceptual tasks generally shows that poor readers do not show the degree of specialised localisation of function experienced by normal readers (Press, 1987). In other words, whilst normal readers evidence a clear preference for the left hemisphere (right ear) in perception on dichotic listening tasks, poor readers show no such preference. To explain the auditory perceptual differences between the normal and reading disabled populations by means of differences in neural functioning would appear to be a feasible option.

(III) MUSICAL PERCEPTION

Much has been learned about the neurology of musical perception by investigating the effects of lesions and damage in various locations of the brain. Like the response to any other stimuli, the response to music can become depressed, and by investigating the conditions under which this may happen some knowledge of the neurology of music processing has been gained. For example, Amusia is the defective perception of music or its components, - timbre, rhythm, melody, harmony and pitch. It has been suggested that there is some degree of bilateral hemispheric representation for musical functions, with a differentiation lying between receptive amusia (correlating to lesions in anterior temporal area of the dominant hemisphere), and expressive amusia (lesions in the minor hemisphere).

Critchley and Henson (1977) emphasised that musical deficits which occur as a result of injury or disease are commonly associated with other deficits in performance. McDonough (1973, cited Gates and Bradshaw, 1977)) studied 49 cases of Amusia and found that 65% of those patients with deficits in music function also had deficits in language function. There have also been reported cases of musical alexia occurring with the retention of normal reading, as well as cases where musical functioning has been normal but associated reading was deficient.

Gates and Bradshaw (1977) issue a cautionary note with regard to the analysis of data in the area of musical neurology and its relationship to the neurology of language. It is often the case that only the novel or "significantly different" cases are published. The data to hand, therefore, may not be truly representative of the numbers of actual cases. For example, a patient who presents with a language disorder and is found to have a concomitant music deficit, may be a common occurrence. On the other hand however, a patient without language deficits, but with a music disorder may not present for treatment because the condition does little to affect his/her way of life (unless that individual has a special interest in music). It could be considered that cases where musical ability is superior, and therefore reported deficits are more marked , may not be truly representative of the general population. Critchley & Henson (1977) noted the possibility that the degree of musical sophistication may correspond with a nervous organisation different from the norm, and associated more with musicial faculties.

Nevertheless, despite the fact that these cases (of marked musical deficits but no concomitant language deficits) are not readily observed, they supposedly still occur. Obviously, in cases where the dysfunction immediately affects the life of the individual (as with a language disorder), a request for remediation will be more likely than in a case where the dysfunction is not so debilitating (as in the case of a music deficit).

In an extensive article which looked at the role of the cerebral hemispheres in music perception and performance, Gates and Bradshaw (1977) promoted the idea that one hemisphere is not dominant for music, but rather there is an interaction of each with the other. This would seem feasible as we appreciate the variety of skills which a musician must call upon when performing. These skills would include (amongst others) intact functioning and integration of the auditory, visual, sensory motor, and gross and fine motor coordination areas. Also it would appear to provide a more satisfactory answer to the problem which remains unanswered in the light of the argument which proposes that only one hemisphere is involved, (and more specifically, the hemisphere opposite that which is involved with language) i.e., how do we explain the intermediary ability to chant, when supposedly we sing with one hemisphere and talk with the other?

From an analysis of research findings, Gates and Bradshaw surmised that, rather than the music per se, it may be the way in which that musical information is processed that determines the role that each hemisphere plays. They proposed that the left hemisphere took a greater role when the analytical and sequential aspects of the music were the focus, but the right hemisphere was superior when the sound gestalt was emphasised.

Some linguistic and musical disturbances have been noted as occurring together, therefore suggesting that, at least for some tasks, the same areas of the brain may be involved. Suggesting that both hemispheres play a contributory role in musical functioning assists in explaining why, in some cases, left hemisphere (language dominant) lesions can lead to musical functioning deficits, and right hemisphere lesions (presumably more music dominant) do not always lead to music disruption.

The trend nowadays seems to be away from the idea of there being a major and a subordinate hemisphere, and towards the concept of hemispheric specialisation. Each hemisphere may specialise in different functions, with the left hemisphere showing superior rates of performance on some tasks and the right hemisphere on others but neither may have exclusive abilities in any one field. The distribution of these specialised functions may differ between individuals. It has been realised also that possibly certain complex functions may be represented in both hemispheres with the two representations being complementary. The notion of music perception may be able to be split into both melodic and rhythmic factors, thus accessing both hemispheres with their own areas of specialisation.

(IV) RHYTHM

The neurology of the perception of rhythm alone, in the absence of melodic input, has received relatively little attention compared with the other aspects of musical performance. As is noted in the majority of Music functioning test batteries, rhythm and melody are usually combined in assessments. For example, in Gordon's Musical Aptitude Profile (1965) the Rhythm Imagery subtest involves both rhythm and melody combined as Gordon considers the two to "interact in an inseparable way". The inter-dependence of these two functions can be appreciated when it is realised that the recognition of a melody is substantially facilitated when the notes are rhythmically grouped. Similarly, some well known tunes may be recognised on presentation of their rhythm alone. However, Thackray (1972) found that the ability to perceive a rhythm in melody may be different to when the same rhythm is separated from that melody. Thackray distinguished between those children who may have more musical ability and experience and those who do not. He suggested that possibly those with greater ability are helped in their perception of rhythm patterns by the addition of melody, whereas those with less musical ability or experience may find the inclusion of melody a hindrance to performance. Thackray's proposals on this matter were influential in the choice of test for this current study. In an attempt to minimise extraneous variables, or decrease the likelihood of children with more musical experience receiving an unfair, albeit unintentional, advantage over the other children, the chosen test for this study did not include melody in the rhythmical passages. The rhythm passages were presented on a one tone pitch.

It is important to note, at this stage, one difficulty which has been encountered surrounding the literature in this area, i.e., the vast majority of research has been done with adults, thus making the generalisation of findings to children, questionable. There is some evidence, although not universally accepted, to suggest that the perception of rhythm may be mediated to some degree by both hemispheres. In their research investigating ear superiority for rhythm identification, Robinson and Soloman (1974) found, however, that the number of correct identifications for the right ear (left hemisphere) was significantly greater than for the left ear (right hemisphere). Performance by the left ear (right hemisphere) nevertheless was still at a level better than chance. Ability to process rhythm may therefore not be <u>exclusive</u> to the left hemisphere, but merely be performed more <u>efficiently</u> in that area. Further evidence that both hemispheres are capable of rhythmic perception comes from the work of Milner (1962). Using the Seashore Rhythm subtest, she found no differences in rhythm perception abilities between right and left temporal lobectomy patients. Differences in performance between the two groups were noted in the Time, Loudness, Timbre and Tonal Memory subtests however. It is possible that differences occurred in these subtests (but the not the rhythm subtest) because the task of discrimination involved perceiving the sound as a whole, rather than just particular elements of the sound, as in the rhythm test. In other words, performance on the rhythm subtest, unlike the other subtests in which differences were noted, is not reliant on perception of the entire gestalt of the presented stimuli.

The Wada technique, also known as the "reversible hemispherectomy", (Bogen and Gordon, 1971), involves unilateral injection of intracarotid amylobarbitone. This technique has allowed for comparisons to be drawn between normal and pathological performances. During right hemisphere depression (with the injection in the right carotid), rhythm was not found to be negatively effected, although the patients were singing off key. Interestingly, rhythm was also unaffected during left hemisphere depression. Rhythm therefore appeared to be served by both hemispheres.

D. SOME METHODOLOGICAL PROBLEMS

As in other research areas, methodological problems (for example sampling errors, and group classification techniques) may lead to the criticism of some research findings in this area. Mather and Kirk (1985), for example, addressed the problem of ascertaining the degree of relatedness between auditory perception and reading disabilities when the probability of a Type III error (i.e., asking the wrong research question) may well mask any true relationship anyway. Obviously, the possibility of a Type III error is not confined to this area of research only, however it is important to consider such problems when evaluating any research study.

Flower (1968) also mentioned another important issue which needs to be considered in the area of assessment of auditory perceptual skills. Indeed, it is an issue which plagues the area of psychometric assessment in general, - namely the problem of matching an appropriate assessment instrument to the area being investigated. The impossibility of constructing and/or using a test which makes demands on only one of the auditory processes, the one in which one is interested, is a major concern. For example, an assessment which may purport to measure auditory discrimination between similar sounding pairs of words, may, in actual fact, also be assessing the ability to attend to the task in hand, hold the first word in memory, and then "match" as requested. What initially may appear to be a simple task of assessing auditory perception may in reality be a complicated task involving an interaction of confounding variables. Problems arise, therefore, in locating an appropriate assessment procedure which measures only that in which one is interested. Not only must the face validity of any assessment be evaluated, but also its appropriateness with regard to its use as an instrument of measurement and possibly prediction.

In a widely reported and acknowledged paper, Hammill and Larsen (1974) mentioned another methodological problem encountered in some studies which purported to measure the relationship between auditory skills and reading ability. In their review of studies which used correlational statistical procedures to investigate the relationship(s) between the two areas, Hammill and Larsen found no evidence to suggest that auditory skills were related to reading ability in any "useful" way. In other words, there did not appear to be, in the majority of cases, a significant difference in the scores on various measures of auditory perceptual abilities between the groups of poor readers and the groups of normal-achieving readers studied. Hammill and Larsen concluded however, that considering that intellectual ability was not controlled for in the majority of these studies, this was not a surprising result at all. They saw the results of populations being grouped by reading ability only, with the result being also an inadvertent split by intellectual ability, - with the poor readers generally having lower IQs. (Note the finding of Lienhard mentioned previously). If intellectual ability is not controlled for by the experimenter, this extra variable will only serve to influence the results. Identification and control of intellectual abilities in this, and other, areas of research is obviously an important factor and one that was considered in the current research project.

HYPOTHESES FOR THIS STUDY

When evaluating the presented neurological data which discusses the areas of reading (dis)abilities and auditory perception, it becomes apparent that some link between the two areas cannot be denied. As a summary of the literature, Zurif & Carson (1970) perhaps typified the accepted view when they stated that the skill of learning to read requires an ability to transform temporally distributed auditory patterns into spatially arranged visual ones. In other words, the ability to read is strongly influenced by the ability to apprehend temporal sequences. If we accept this view, it is feasible to postulate therefore, that children with a reading disability will show inferior performances on tasks designed to measure the accuracy of auditorily presented rhythm pattern perception, when compared to their non reading disabled peers .

As Atterbury (1983) stated,

> .... nonverbal processing (rhythmic) that presumably occurs in the left hemisphere and verbal processing (reading) that also takes place in the left hemisphere may be significantly associated... (this) suggests the possibility that learning-disabled children with reading dysfunctions may also have dysfunctions in processing rhythm.
>
> (p.261)

This study aimed to investigate the differences in the discrimination of auditorily presented rhythm patterns between a group of reading disabled children and a group of non reading disabled children. It was hypothesised that the reading disabled children would perform less well than their non reading disabled peers on an auditory perceptual task.

Also, if we are to accept the proposal that there are differences in neural functioning between the sexes, it was hypothesised that the males in this current study would perform the auditory perceptual listening task less well than the females. Although rhythm is perceived and processed in both hemispheres it is done so more effectively in the left hemisphere. As discussed earlier, females show superior performance on tasks requiring left hemisphere functioning, whilst males appear to show superior performances on tasks requiring the functioning of the right hemisphere.

METHOD

A. SUBJECT SELECTION

(I) DEFINING THE GROUPS, - A QUESTION OF TERMINOLOGY

This study was initially influenced by Betty Atterbury's work in the early 1980s in which the musical processing differences between groups of learning disabled and normal readers were investigated. Atterbury's incentive for her work appeared to lie in the hope that learning disabled children would not only be recognised as such, but that each child would also be provided with education that was directly appropriate to his/her needs. She stated,

> Music instruction for groups containing normal and exceptional learners needs assistance from research which investigates possible musical processing differences in normal-achieving compared with mainstreamed exceptional populations.
>
> (p.259)

The term "exceptional learners" however poses a definitional problem due to the heterogeneity of subgroups it includes. As well as debate concerning the definitions of specific subgroups within the "exceptional" populations, terminology also varies between countries. For example, in the United States of America the term "learning disabled" is used synonymously with others such as "developmental disability", "minimal cerebral dysfunction", "educationally handicapped", and "educationally subnormal" to name but a few. Included in this list is also the term "specifically learning disabled". In New Zealand, however, the term "specific learning disabilities" is used to refer only to those who, despite average or above average intellectual ability, suffer some degree of perceptual and/or expressive disability which is not caused by primary sensory dysfunction i.e., auditory or visual disability, or primary emotional disturbance. Due to these differences in terminology, comparisons between studies are often difficult. In some studies the task of comparing results is made even more difficult because the subject groups are inadequately defined. It is therefore crucially important to be specific with regard to the criteria used for the classification of any group of subjects. As well as giving a clearer indication of the subgroup with which one is working , this will also assist with future comparisons with other studies, should this be desired. With this in mind, a precise indication of the measures used to classify the experimental and control groups in this study is outlined below.

Aman and Singh (1983) summarised this complicated area of terminology surrounding the area of children who show average or above intelligence and yet suffer some degree of reading deficit. Specifically, they drew attention to the distinction drawn between "Reading Backwardness" and "Reading Retardation", the former referring to the difference between one's chronological age and reading age (Pilliner and Read, 1972) and the latter being the discrepancy being one's mental age and reading age. The distinction between the two terms depends on whether the deficit is based on a comparison with one's peers or with one's own ability. While the benefit of both these terms is that they allow for objective measurement, the possibility of individual variations in development make comparions with one's peers sometimes questionable.

In their review, Aman and Singh concentrated mainly on the group they saw as being reading retarded i.e., there was a discrepancy between the child's reading attainment and his/her mental age. One reason they gave for their concentration on this area was because these children are "inherently interesting" due to the unexplained differences in their abilities. This issue is accepted whole-heartedly in this current study, and is acknowledged as one of the main reasons why this particular research project using these children was initially considered.

Whereas Aman and Singh referred to these children as being "reading retarded", the current study uses the term "reading disabled". This difference in labelling is an attempt to rid the area of reading deficits from the negative connotations which accompany the use of the word "retarded". It is unfortunate that this word is often only associated with cases of pervasive intellectual retardation and not just the specific area of deficit to which one is referring, in this case "reading retardation". The term "reading disabled" perhaps gives the impression of a more "treatable" disability than does the term "reading retarded".

(II) THE USE OF EXPECTANCY SCORES

The use of "expectancy scores" i.e., the discrepancy between actual achievement and assumed potential, as a criterion for classifying any group, has received wide debate. Hoffman (1980) addressed the question of the validity of the concept of discrepancy identification, and asked "what confidence do we have in the strength of the correlation between the predictor (the Mental Age) and the criterion (reading achievement)?". This, after all, is the basis upon which we place our reasoning for using expectancy scores. There has also been concern voiced regarding the false sense of scientific accuracy which sometimes accompanies the use of any kind of mathematical formula.

More specifically, there has been some criticism of the use of IQ scores as valid measures of intellectual potential (Stanovich, 1989). (The long-running debate regarding "what is intelligence?" and "is it a measurable concept?" lies at the base of these arguments.) To critics such as Stanovich the interpretation of assessment scores when investigating discrepancies between supposed potential and actual achievement seems incomprehensible. In a similar vein, Siegel (1989) also criticised the use of intelligence tests (particularly when assessing children with learning disabilities) and the use of the discrepancy definition when classifying groups. As an example she gives the case of a child from a disadvantaged or minority background who may achieve spuriously low scores on an intellectual assessment.

This child is subsequently incorrectly classified as being a "slow learner" rather than being "learning disabled" due to the lessened discrepancy between his/her potential (as scored on the intellectual assessment) and actual achievement. The assumed pervasiveness of the child's general cognitive deficit may then lead to his/her exclusion from educational programmes from which some benefit may otherwise have been gained. The detrimental effects of labelling, or more specifically mis-labelling are a strong point of argument. A concerned researcher can only ask him/herself however, "what are the practical alternatives available in a situation where a child's achievements are to be justly evaluated?"

Problems may occur when classifications are made on the basis of insufficient data (e.g., with the consideration of Mental Age only). It is also fair to see that criticisms may occur in such situations where pupils are denied entry to certain programmes on the basis of decisions made with reference to their projected potential. As a possible solution, Hoffman raised the issue of realising the usefulness of using listening comprehension as a predictor of language abilities. Stanovich extended this idea further by proposing that instead of using intellectual assessment results, an evaluation of the discrepancy between reading comprehension and listening comprehension scores could be used as a predictor of language abilities. The idea being that if a child better understands material presented to him/her aurally rather than visually, then the processes of word recognition and subsequent comprehension must be at fault.

The ongoing debate concerning intellectual assessments, their administration and analysis, is typical of the concerns in other areas of psychometric assessment where tests and scores are involved. As measuring instruments, test batteries are as open to abuse and misinterpretation as any other tool used by any worker in any field. The aim, of course, is to achieve further insight into a situation, and if this is done through the appropriate choice, administration and interpretation of standard psychometric tests as well as an appreciation of the child's physical, social and emotional situation, then a valid measure of the construct one wishes to assess is more likely to be gained.

Expectancy scores, in which discrepancies between potential and achievement were evaluated, were used in this current study to decide group placement as they were seen as being a fair assessment of the children involved. All children were of average or above intellectual ability and had English as a first language, thus decreasing the likelihood of their being disadvantaged on formal tests.

(III) SUBJECT GROUPS IN THIS STUDY

With the above cautionary notes in mind, this current study's classification of the group referred to as "reading-disabled", as distinct from that group of "normal achieving" readers, resulted from consideration of WISC-R (Wechsler Intelligence Scale for Children - Revised) Full Scale IQ results, calculated Mental Ages using these FSIQ results, and reading age scores achieved on the Neale Analysis of Reading Ability (3rd Ed.). Each child in the experimental group (of "inherently interesting" children) in this study was classified as being "reading disabled". Despite average or above intellectual ability (as scored on the WISC-R), it was found that his/her Reading Age (as scored on the Neale Analysis, 3rd Ed.) was below that which would be accepted as being commensurate with his/her Mental Age, i.e., there was a discrepancy between potential and actual achievement.

As well as a specific Reading Age, the Neale Analysis of Reading Ability test battery provides an "Equivalent Age Range" level for every raw score that can be achieved on the test. This age range is provided to give an indication of a predicted age range in which the given score would be considered to be an average accomplishment. The classification of a child into either the experimental or control groups in this study was done on the basis of considering his/her Mental Age, and comparing this with his/her score and associated Equivalent Age Band as achieved on the Neale Analysis. If the child's mental age was within the boundaries of this age band he/she was placed in the control group i.e., the "normal achieving" or non reading disabled group. If, however, the child's mental age was above that of the upper limit of his/her achieved reading age, placement was in the "reading disabled" or experimental group.

The group of "reading disabled" children in this study may be differentiated from other "poor readers" in that no primary sensory disabilities were present. Every child involved in this research was required to have been assessed for both primary auditory and/or visual dysfunctions. In the majority of cases this consisted of having received clearance from the Public Health Nurse who visited the child's school. If concern had been expressed at either an individual level or owing to familial predisposition to problems, some children had also received follow-up assessments from Opthalmologists or ENT specialists, with a few receiving eye exercises for eye tracking deficits. Owing to the nature of this research project, any child with a degree of auditory dysfunction or a history of Otitis Media requiring intubation was excluded from participating. There was also no evidence of any degree of sensory-motor disability in any child. Those children who were involved in any occupational therapy or other coordination based intervention programme were not included in the study.

The children came from a variety of schools within Christchurch and the surrounding areas. All children had English as a primary language and had histories of regular school attendance. (Refer to section C-1 for information regarding subject recruitment).

B. TEST SELECTION

(I) MUSIC ASSESSMENT BATTERIES

There are a number of music assessment batteries available for use. Closer analysis of these indicate that some are focussed on aptitude while others aim at assessing ability. Before discussing the merits of the Seashore Rhythm Test, and the reasons why it was deemed an appropriate testing instrument for this study, a brief overview of some of the other available batteries and their rhythm assessment component would seem appropriate.

The Musical Ability in Children assessment battery, (Bentley,1966) is widely recognised as an efficient tool for measuring musical aptitude in young children. New Zealand norms for this test were published by Hogan in 1970. The battery involves assessment of four areas of musical aptitude, i) Pitch Discrimination, ii) Tonal Memory, iii) Chord Analysis, and iv) Rhythmic Memory. The rhythmic memory subtest not only requires the subject to discriminate whether the presented pairs of rhythmic patterns are the same or different, but also to state on which beat any alteration (in the case of a different pattern pairing) occurs. For the purposes of this study, it was considered that this additional requirement was too complex.

The Drake Musical Aptitude Test (1954) involves tests of musical memory and tests of rhythm. The rhythm test is not a test of discrimination per se as it requires the subject to continue counting at a regular pace during a period of rest and then give the number of missing beats between the end of one segment and the beginning of another, as an answer.

The Musical Aptitude Profile, or MAP (Gordon, 1965) was designed to minimise musical achievement so that the basic components of musical aptitude could be assessed. These components are musical expression, aural perception, and kinesthetic musical feeling. The battery looks at tonal imagery (harmony and melody), rhythm imagery (tempo and meter), and musical sensitivity (phrasing, balance, and style). The rhythm imagery subtest involves both rhythm and melody as Gordon states the two interact. Whilst this battery was considered as a possible choice for this study it was decided that, in the interests of controlling possible extraneous variables, the Seashore Rhythm test, which does not include pitch as a component, was a more appropriate choice.

(II) THE SEASHORE MEASURES OF MUSICAL TALENTS

Revised editions of the Seashore Measures of Musical Talents (Seashore, Lewis, & Saetveit, 1919) were published in 1939 and 1960. The first revision, in 1939, resulted in an improvement of some stimuli as well as the replacement of the consonance test with a timbre test. Critchley and Henson (1977) classified this test battery amongst those tests which are "based on psycho-physical measures of auditory perceptions with little recognisable musical content". The battery is designed for use with subjects of fourth grade level i.e., 9 years of age and above, and comprises six subtests measuring six different components of musical ability, namely pitch, loudness, timbre, time, tonal memory, and rhythm.

The test manual states clearly that it is important to understand intra-individual differences with regard to strengths and weaknesses, but the important area of musical ability is not tapped by many "typical scholastic or general aptitude tests". Seashore's theory of musical talent claims that it cannot be regarded as a single entity but consists of six different abilities which operate quite independently of each other. According to Seashore, in order to realistically embark upon a career as a professional musician one would need to achieve highly on those ability tests appropriate to the instrument being played, e.g., a high rhythm score and lower pitch score would indicate a musical career on a percussion instrument rather than a stringed instrument to be appropriate. An evaluation of Seashore's theory is provided by McLeish (1968) in which he questioned the notion of Seashore's six specific musical talents and proposed that, following a method of factor analysis, there was instead a group factor present. Nevertheless, the Seashore battery tests what it purports to assess and as such provides a valid measure of the six abilities.

Seashore's assertions that his Measures of Musical Talents battery measures six separate and independent abilities allows for each subtest to be administered in its own right. Following on from this however, is the equally important realisation that any conclusions reached about a subject's performance must be limited to the particular subtest administered. In other words, a score in the 99th percentile on one test cannot be generalised across to mean an equivalent score on the other tests if these are not assessed independently. Also, test scores should not be averaged to provide a single indicator of musical ability as each score is a single item on an individual's musical profile.

Norms for the Seashore battery of tests are available for three different educational levels, i) Grades 4-5 (approximate age equivalent is 9-10 years), ii) Grades 6-8 (11-13 years), and iii) Grades 9-16 (14 years to adult). Preliminary investigations into score distributions amongst single grades resulted in the above grade splits being justified due to sufficient differences in scores being gained at these levels. Only combined sex norms are provided as only small and inconsistent between-sex differences were noted.

The Rhythm test comprises 30 pairs of rhythmic patterns presented to the subject(s) on a long playing record. The sound stimuli is a beat frequency oscillator set at 500 cycles per second. Tempo is constant at 92 quaver beats per minute. The first ten pairs presented contain 5 notes in 2/4 time; the next ten are of 6 notes in 3/4 time; and the last 10 are of 7 notes in 4/4 time. The subject is required to indicate whether the two patterns presented in each pair are the same (signified by printing "s" on the answer sheet) or different ("d").

(III) USE OF THE SEASHORE RHYTHM TEST WITH 'EXCEPTIONAL' LEARNERS

Zurif and Carson (1970) used the Rhythm subtest of the Seashore battery in their investigation of possible auditory perceptual processing differences between a group of normal readers and dyslexics. Their results showed that the normal readers performed significantly better than the dyslexics on this task of rhythmic discrimination.

A study by Decuir and Braswell (1978) used the Seashore battery of tests in an attempt to compile a musical profile i.e., an idea of potential and capabilities, for 31 learning-disabled students, aged between 10 years 1 month and 15 years 1 month. The pitch, loudness, rhythm, time and tonal memory subtests were administered to this group of students, all of whom were of average or above intellectual ability, with no evidence of emotional disturbance. It is important to note the heterogeneous nature of these 31 children, with regard to their learning disabilities, - 13 having a visual learning disability, 5 having an auditory learning disability, and 13 showing mixed symptoms i.e., a mixture of visual, auditory and motor disabilities. Decuir and Braswell's results confirmed their hypothesis regarding the lack of significant differences between the subtest scores for the 3 groups of learning disabled students. In other words, the Seashore Measure of Musical Talents did not discriminate <u>between the subgroups</u> used in this study. However, the percentile rankings achieved by the groups separately, and as a whole, were below those expected for a normal population. In other words, the Seashore battery was unable to discriminate between learning disabled groups, but could do so between learning disabled and "normal" controls. Some caution must be expressed regarding the interpretation of these scores however. As Decuir and Braswell themselves indicate, the small number of subjects used limits the degree to which these results can be generalised to another population. A bigger sample size would eliminate any spuriously high or low scores on the subtests.

(IV) USE OF THE SEASHORE RHYTHM TEST IN THIS STUDY

One of the aims of this study was to investigate the notion that children who suffer some degree of reading disability may also evidence some degree of auditory perceptual dysfunction. As such, the use of the Seashore Rhythm test was considered to be an appropriate assessment. It has the added advantage of not only providing information concerning the presence or absence of such dysfunction but also that it may allow some insight into the differing requirements of such children in the field of music education. This is an important consideration when music is being used increasingly in schools nowadays as an integral part, rather than just an optional addition, to more traditional teaching styles. To minimise the possibility of previous music education and exposure inadvertently influencing the test scores recorded by each child, the Seashore Rhythm test was considered to be particularly appropriate as it does not include melodic input in the rhythm tests. This point was mentioned earlier in this review when the work of Thackray was discussed.

The Seashore battery had also been used in a number of previous studies (Atterbury, 1983. Zurif & Carson, 1970. Decuir & Braswell, 1978. Boone & Rausch, 1989) and was obviously considered to be a valid measure of musical abilities. It provides a measure of rhythmical analysis without the possible influences (whether they be detrimental or beneficial) of melodic input.

(V) READING ASSESSMENTS

A primary concern for the researcher in this study was the desire to find a reading assessment that allowed not only for the computation of a reading age but was also preferably normed for the New Zealand school age population. An obvious choice would have been the Reading tests from the Progressive Achievement Tests series (Elley & Reid, 1969) which are administered to New Zealand school children at the beginning of each year. As parallel forms are available for these assessments, one possibility was to administer that form which had not already been administered in the school setting earlier in the year. However, if the schools wished to readminister the PAT test for any reason, they themselves may have wished to use this parallel form.

Owing to the novelty of the test situation with regard to the Seashore Rhythm test, which was to be administered immediately following the reading assessment, it was considered desirable that individual administration of the chosen reading assessment be possible. Although this would have been possible with the PAT series of tests it was considered that the test situation, and materials, would have been familiar enough to many of the children to have provoked possible unnecessary anxiety when the conditions were associated with previous similar tests "at school". Due to the fact that some of the children had been selected for inclusion in this research study specifically because of their presumed reading disabilities and concomitant failing experiences at school, it was considered important that the test situation they were to experience for the purposes of this study should not be unnecessarily stress provoking due to associations being drawn between these conditions and those experienced in the school setting. A different test of reading ability was therefore seen as being a favorable option. Whilst the chosen test was to provide similar information as would have been gained from having administered the PAT tests, the change in format and appearance would hopefully assist in minimising the above mentioned problems. For these reasons, the use of the PAT reading test was not considered to be the most appropriate choice.

Consideration was also given to the New Zealand revision of the Burt Word Reading Test (Gilmore, Croft & Reid, 1981). Whereas this assessment battery may have proved an acceptable option, the availability of the Neale Analysis of Reading Ability (3rd Ed. 1989) provided a more up to date alternative. Also, the

Burt Word Reading Tests only provides words to be recognised out of context rather than as a "reading" test per se in which comprehension of text is required. For this particular study, the Neale Analysis was chosen for use as it appeared to be the most appropriate choice available.

(VI) THE NEALE ANALYSIS OF READING ABILITY (3RD. REV .ED.)

The Neale Analysis of Reading Ability was published initially in 1958. It has been one of the most widely used reading tests throughout Australia, the United Kingdom and New Zealand. Unfortunately, New Zealand norms are not available for the Neale Analysis of Reading Ability (3rd.Ed.), however it was considered to be an up-to-date assessment as well as one in which provision was made for the calculation of a Reading Age.

The Neale Analysis of Reading Ability is for children between the ages of 6 years and 12 years. There are two standardised parallel forms available. Each form consists of six passages of prose, graded to appropriate age levels. Each prose is a complete story, - its content matter and sentence structure being appropriate to the age level. Reading Ages can be calculated on the passages for a) Reading Accuracy - in which reading errors are analysed, b) Reading Comprehension - in which simple questions are asked regarding the content and/or implications of what is read, and c) Reading Rate - in which the speed of reading is noted. Norms are available for each of these three aspects also. Included as well in the test are three supplementary diagnostic tests, namely a test of letter and sound recognition, a short spelling test, and an assessment of syllabic and phonic blending ability.

The administration of the Neale Analysis is relatively simple. Before testing commences, the child is informed that help will be given should he/she find a particular word or item difficult. The assessment procedure is therefore able to remain on a positive basis. Inclusion of pictures with each prose passage allows also an excellent starting point for discussion, thus providing opportunities for establishing rapport prior to testing. In addition, a practice passage is provided for the child prior to the commencement of formal testing. Reading of the set prose segments is continued until the child is seen to have made sixteen errors, after which testing is ceased. If passage 6 is reached, testing ceases after twenty errors are made. The tester is required however, not only to mark the number of errors, but also to identify these as errors of i) mispronunciation, ii) substitution, iii) refusal, iv) addition, v) omission, or vi) reversal. The analysis of errors in this fashion has obvious diagnostic value as it allows for particular problem areas to be identified and subsequent teaching to be concentrated on these.

Calculation of a Reading Age is made by subtracting the number of errors, in each of the first 5 passages, from 16 (except in the case where passage 6 has been reached in which case the error number is subtracted from 20). These scores are then totalled and the Reading Age is calculated by translating the final score by means of the table provided in the test manual. Both a "Reading Age" score and an "Equivalent Age Range" score is available.

C. PROCEDURE

(I) SUBJECT RECRUITMENT

The subjects for this study were selected from a larger population of over two hundred children who had been assessed by the researcher at the SPELD N.Z. Centre, McKenzie House, Christchurch. McKenzie House is a research, assessment and teaching centre for children and adults with specific learning disabilities. Referrals for assessment at the Centre are received from a variety of sources, including parents, teachers, school principals, paediatricians, and doctors. The majority of referrals are received from parents.

The children in the current study had presented at the Centre for assessment of intellectual ability (as measured by the WISC-R) and later assessment of suspected Specific Learning Disabilities. As mentioned, those children included in this study were selected by age, Full Scale IQ, absence of primary visual and/or auditory dysfunction, absence of primary emotional disturbance, and history of regular school attendance. This information was confirmed by a standard case-history form which the parents are required to complete for their child when they initially present at the Centre. Developmental history, academic strengths and weaknesses, and hobbies and interests were noted on these forms. Information regarding the regularity of school attendance also provides an indication of the child's health record e.g., does the child suffer regular illness thus influencing school attendance. Similarly, the presence of an emotional disturbance is noted as possibly detrimentally affecting school attendance as well as other situations in which the child may be required to mix socially with other children.

By considering the results of the reading assessment done at the time of the child's intial assessment for suspected specific learning disabilities, an approximation was obtained regarding his/her possible group placement for the current study. This was used as an approximate indication only as it was usually some time since that assessment had been done. It was possible to select children who were and were not suspected to be "reading disabled" owing to the heterogeneity of children presenting for assessments at McKenzie House. Whilst some children had received individual specialised tuition following their assessments at McKenzie House, others had not.

Initially sixty children were selected to be contacted concerning involvement in the study (Appendix 1). Each child's parents were written to regarding the research project and its objectives. There was approximately an 80% return rate of letters requesting permission to involve their child in the study. Of those letters returned, only three subsequently declined permission for their child to be involved. Only one declined on the basis of not wanting her child to be involved in another testing situation, with the other two declining because the child in question no longer lived in Christchurch.

On presentation for assessment of the Neale and Seashore batteries, each child's parent(s) completed a Consent form giving written permission for their child to be involved (Appendix 4). Parents were also given the option of receiving a summary of the research findings upon completion. They were asked to complete an address form if they wished this summary to be sent to them.

(II) TESTING CONDITIONS

Each child in this study was assessed on an individual basis. His/her WISC-R assessment had been administered at some stage previous to the Neale Analysis and Seashore Rhythm test administration appointment. Total testing time per child was approximately 2 hours 30 mintues. As previously mentioned, the WISC-R had been administered by this study's researcher at the time of the child's initial presentation at McKenzie House. The time span between the WISC-R and the other two test administrations ranged from 4 months to 2 years 3 months.

Consideration was given to the possible necessity of readministering the WISC-R to some of the children who had experienced a longer time span between their initial assessment on this battery, and the later testing on the Neale Analysis and Seashore Rhythm test. After all, it was on the basis of a child's Full Scale IQ score that his/her Mental Age was calculated and subsequent classification as "reading disabled" or "non reading disabled" was made when this was compared to his/her score on the Neale Analysis. Consideration of the findings of Lally, Lloyd & Kulberg (1987) was influential in the decision not to readminister the WISC-R however. They evaluated the necessity of readministering the WISC-R to "learning disabled" children every 3 years, as is a requirement when such children are identified and placed in special educational services under Public Law 94-142 (Education for All Handicapped Children) Act 1975, in the United States. "Learning disabled" children are identified as those with a discrepancy between ability and achievement. Although the WISC-R has been proven a stable indicator with some populations, Lally et al wished to investigate this reliability with a population of learning disabled children, - especially over the time period of 3 years which is the limit allowed for reassessment under PL 94-142. (This time period was especially fitting to this study, because the longest time between assessments was still within this 3 year period.)

Lally et al found that for the learning disabled population they assessed, there were no significant differences between the test-retest scores on the Verbal, Performance or Full Scale IQ scales. In other words, the WISC-R is as reliably stable for learning disabled children as it is for non learning disabled (or "normal") children, within a 3 year retesting period. Readministration of the WISC-R to the children in this current study, whether they be labelled "learning disabled" or not, was therefore not considered to be necessary.

In the first of the two assessment appointments for each child a full WISC-R was administered, with no pro-rating of scores. The Neale Analysis and Seashore Rhythm tests were administered together in the second of the assessment appointments. In the majority of instances during this second assessment time, the child's parent(s) were present during the testing. They were requested to sit quietly behind the child and were not actively involved throughout the session. Both assessment sessions were held in a quiet room, away from noise and visual distractions.

The Seashore Rhythm test L.P. recording was transferred onto a tape cassette for easier transportation and increased clarity of sound. The cassette player was place directly in front of the child, approximately 2-3 metres away. Some of the reading disabled children were known to have poor sound-to-letter correspondence and it was considered that this could detrimentally affect their performance if they were required to write "s" for "same" and "d" for "different" as the test requires. With this in mind, the administration of the Seashore Rhythm test was adapted so that the child only had to report "same" or "different" and the researcher wrote down "s" or "d". This procedure was put in place for <u>all</u> children and did not result in any problems.

RESULTS

The subject population comprised 45 children. The children were divided into four groups, by sex and reading ability.

(i) female non reading disabled (n = 11),

(ii) female reading disabled (n = 9),

(iii) male non reading disabled (n = 12),

(iv) male reading disabled (n = 13).

There were 20 girls and 25 boys, including 23 non reading disabled children and 22 reading disabled. (see Table 1). Raw test data is shown in the Appendix 9.

TABLE 1: GROUP NUMBERS, BY SEX AND READING ABILITY

	READING DISABLED	NON READING DISABLED	TOTAL
FEMALE	9	11	20
MALE	13	12	25
TOTAL	22	23	45

The children's ages ranged from 9 years 0 months to 11 years 10 months (mean = 10 years 1 month). Ranges and Standard Deviations of chronological ages for the four groups are shown in Table 2.

As allocation to either the Reading Disabled or the Non Reading Disabled group relied on the basis of the discrepancy between Mental Age and Reading Age, it was necessary to calculate each child's Mental Age from his/her Chronological Age. This was done using the standard equation for such conversions, i.e., initially dividing the Chronological Age by 100 and then multipling it by the child's Full Scale IQ, i.e.,

$$\frac{CA}{100} \times FSIQ = MA$$

TABLE 2: Means, Standard Deviations, and Ranges of Chronological Age, Full Scale IQ, and Mental Age Across the Four Groups

GROUP	CHRONOL. AGE Mean (Std.Dev.) (Range)	FSIQ Mean (Std.Dev.) (Range)	MENTAL AGE Mean (Std.Dev.) (Range)
Female Non Read. Disabled	10.3 (9.921) (9.0-11.8)	107 (12.42) (98-136)	10.11 (7.968) (10.1-12.2)
Female Reading Disabled	10.1 (9.458) (9.3-11.6)	113 (11.381) (102-132)	11.6 (15.248) (9.6-13.4)
Male Non Read. Disabled	9.11 (11.572) (9.0-11.10)	105 (6.807) (96-122)	10.6 (16.533) (8.10-13.8)
Male Reading Disabled	10.1 (7.201) (9.0-11.2)	110 (8.635) (99-127)	11.2 (10.795) (9.6-13.0)

(all ages are in years and months)

Two factor ANOVA showed the chronological age differences between the reading ability groups were not statistically significant ($F(1,41) = .001$, $p > 0.05$). There was no significant difference between the male and female groups' chronological ages also ($F(1,41) = 0.31$, $p > 0.05$) There was no significant interaction between the two factors, sex and reading ability. ($F(1,41) = 0.556$, $p > 0.05$). (Appendix 6).

Two factor ANOVA showed the FSIQ differences between the reading ability groups were also not statistically significant ($F(1,41) = 3.069$, $p > 0.05$). There was no significant difference between the male and female groups' FSIQ scores ($F(1,41) = .725$, $p > 0.05$). There was no significant interaction between the two factors ($F(1,41) = .059$, $p > 0.05$). (Appendix 7).

Table 3 shows the mean, range, and standard deviation of Reading Ages for each group.

TABLE 3: Ranges, Means, and Standard Deviations of Reading Ages Across the Four Groups.

GROUP	RANGE OF READING AGES	MEAN READING AGE	STANDARD DEVIATION
Female Non Read. Dis.	9.8 - 12.1	10.8	10.657
Female Read. Dis.	6.9 - 10.7	8.10	16.477
Male Non Read. Dis.	8.5 - 12.6+	10.2	14.617
Male Read. Dis.	7.5 - 10.2	8.8	10.76

(all ages are in years and months)

The difference between the reading ages of the reading disabled groups and those of the non reading disabled groups was significant ($F(1,41) = 26.35$, $p < 0.001$). There was no significant difference between the reading ages of the male and the female groupings ($F(1,41) = 1.208$, $p > 0.05$). There was no significant interaction between these two factors, ($F(1.41) = 0.32$, $p > 0.05$). (Appendix 8).

Scoring for the Seashore Rhythm test is based on a number correct score, with the maximum score being 30. Although the Seashore Rhythm test provides a table in which Raw scores may be converted to Rank scores, it was decided to use the Raw scores per se without further conversion into Rank Scores. The reason for this decision was that apart from the top four Raw Scores i.e., 27, 28, 29, and 30 which are all scored as Rank 1, and the lower scores of below 15 which are all scored as Rank 10, the middle Raw scores (i.e., 16 - 26) are allocated a rank number on the basis of a 1:1 match-up. i.e., Raw score 26 = Rank 2, Raw score 25 = Rank 3, Raw score 24 = Rank 4 etc. By recording Raw scores only it was possible to gain a more precise idea of score ranges without losing the top 4 scores into one ranking (Rank 1), and the lower scores similarly all into Rank 10.

Group scores for the Seashore Rhythm test (SRS) are indicated in Table 4.

TABLE 4: **Seashore Rhythm Test Scores Of the Four Groups (Mean, Standard Deviation, and Range)**

GROUP	MEAN SEASHORE RHYTHM TEST (SRS) SCORE (STANDARD DEVIATION)	RANGE OF SCORES
Female Non Reading Disabled	25.636 (1.63)	23 - 27
Female Reading Disabled	24.333 (1.66)	22 - 26
Male Non Reading Disabled	23.333 (2.9)	15 - 26
Male Reading Disabled	23.231 (4.32)	15 - 28

Both the female reading disabled and the female non reading disabled groups achieved higher mean SRS (Seashore Rhythm Test) scores than their comparable male groups. Although an analysis of variance (ANOVA) does not show a statistically significant between-sex SRS score difference at 0.05 level, the obtained difference is within the range of it being suggestive of there being a significant difference between the performances of the females and the males, ($F(1,41) = 3.591$, $p =$

0.0652). The differences in SRS scores between the reading disabled and the non reading disabled groups, for both sexes, were not statistically significantly different, ($F(1,41) = .612$, $p > 0.05$). There was also no significant interaction between the two factors (sex and reading ability/disability), ($F(1.41) = .446$, $p > 0.05$). (Refer Table 5).

TABLE 5: TWO FACTOR ANOVA, FOR SEX AND READING (DIS)ABILITY ON SRS (SEASHORE RHYTHM TEST SCORE).

Anova table for a 2-factor Analysis of Variance on Y 1 : SRS

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Sex (A)	1	32.014	32.014	3.591	.0652
RD/Non RD (B)	1	5.454	5.454	.612	.4386
AB	1	3.978	3.978	.446	.5079
Error	41	365.52	8.915		

There were no missing cells found.

A correlation coefficient was calculated, for all four groups together, between Reading Age and Seashore Rhythm Test Score (SRS) to determine the degree of their relationship. A weak correlation of $r = 0.287$ was obtained. When the four groups were calculated separately, the greatest correlation between the two factors was gained by the female non reading disabled group, $r = 0.438$.

In summary, therefore, the current study failed to find a statistically significant difference between the auditory perceptual (including discriminative) abilities of the reading disabled and non reading disabled groups. However, a difference which was within the range of being suggestive of a significant difference was found between the females' and the males' auditory perceptual abilities. There were no significant differences in chronological age or FSIQ across the four groups but there was a significant difference in reading ages between the reading disabled and the non reading disabled groups.

DISCUSSION

(I) THE NON SIGNIFICANT DIFFERENCE BETWEEN THE AUDITORY DISCRIMINATIVE ABILITIES OF THE READING DISABLED AND NON READING DISABLED GROUPS

This study did not find a statistically significant difference between the auditory discrimination abilities of reading disabled and non reading disabled children when tested on the Seashore Rhythm test. This test requires the perception of auditorily presented rhythm patterns and subsequent identification of the presented pairs as being either the same or different. It was found that the two experimental groups (female reading disabled, and male reading disabled) did not differ significantly from the two control groups (female non reading disabled, and male non reading disabled) on their discrimination of the same/different rhythm patterns presented.

These results are similar to the findings of Atterbury (1983) in which the auditory discriminative skills of impaired readers and normal readers, aged seven, eight, and nine, were found to be similar. Atterbury's findings regarding the significantly different performance skills of the two ability groups were not tested in this study. The current study did not assess performance abilities per se, but only discriminative abilities in an attempt to further investigate one specific area in which processing differences between reading disabled and non reading disabled children may occur. Whilst it is recognised that future research in this area could investigate further the possible performance skill differences between groups of reading disabled and non reading disabled children, the necessity to thoroughly investigate one stage of the process before extending into other areas is crucial. As Johnson & Myklebust's (1967) model of learning disabilities implied that processing difficulties may arise in either the receptive, integrative or expressive modes, the current study chose to focus exclusively on the receptive and integrative areas, whilst excluding any possible compounding effects of influential output conditions i.e., imitative versus join-in modes of performance, as used by Atterbury.

When considering the results of this study, an important point to remember was that made by Hammill and Larsen (1974) in their evaluation of a number of studies in this area. They too failed to find sufficient evidence of significant differences between reading disabled and non reading disabled groups' performances on auditory perceptual tasks. They noted, however, that in the majority of studies they evaluated, the variable of IQ had not been controlled and it was this influential variable which may have accounted for the differences noted in some studies. In other words, when the children had been split into reading disabled and non reading disabled groups, an inadvertent split in IQ had also been made with the result being that the reading disabled children generally had lower IQ scores than the non reading disabled children. This very issue was raised earlier in discussion, when the work of Flynn and Byrne (1970) was reviewed. Barwick et al's (1989) use of the correlational method in their research was also influenced by the fact that the "potentially relevant" factor of IQ could be partialled out.

With this in mind, IQ in this current study was a controlled variable. Only those children who were of average or above intellectual ability were included in this study with the result being that all groups were of comparable intellectual ability, with no significant differences in mean FSIQ scores being noted between the four groups. The mean FSIQ scores of the four groups ranged from 105 to 113. Using Hammill and Larsen's proposal, it could be speculated that the non-appearance of significant auditory discriminative differences between the reading disabled and non reading disabled groups in this study could be due to the non-occurrence of significant differences in FSIQ scores between the groups. The reverse of this would state that the occurrence of significant differences between the auditory discriminative abilities of reading disabled and non reading disabled groups may have occured in other studies due to inadvertent intellectual ability differences between the groups.

It should also be noted that the children used in this study were older than those used in Atterbury's work. In her studies the children ranged between 7 to 9 years of age whilst the children in this study were older, with ages ranging from 9 years 0 months to 11 years 10 months (mean age = 10 years 1 month). This age range was chosen especially as it was envisaged that, should results similar to those of Atterbury be found, it would be advantageous to be able to identify an older age group as having performed in a similar manner. In other words, Atterbury's findings with the younger age group have been replicated in this study with an older age group, thus decreasing the likelihood that Atterbury's results, or indeed these results, could be explained away as being only an anomoly of a "developmental stage".

As proposed by the vast amount of literature surrounding the area of reading abilities and auditory perception, the ability to acquire the skill of reading is influenced to some degree by auditory perceptual abilities. This cannot be denied even if one only considers the summary of material in this area, as presented in the earlier discussion in this study. However, as auditory perceptual ability was not found to be a significant discriminator between the two ability groups in this current study, it is logical to propose that other influences on the acquisition of reading must also be present. In other words, whilst auditory perceptual abilities may well be necessary in the area of reading skill acquisition, they alone are not sufficient but are only one area amongst others.

Future research may do well to further investigate other possible influential areas. Some research proposals may include, for example, investigating the role of early childhood exposure to written text, initial learning experiences and expectations, phonological awareness and ability in letter-to-sound correspondence prior to formal language tuition etc. If differences in auditory perceptual skills cannot account for the differences in reading ability between the groups, what other explanations may be proposed? The current study has served to highlight the necessity to also consider other areas in our ongoing quest to comprehend more fully the area of reading disabilities. It is not envisaged that, to date, an exhaustive list of possible causes has been considered and an open mind regarding other alternative explanations should be encouraged.

(II) THE DIFFERENCE BETWEEN THE AUDITORY DISCRIMINATIVE ABILITIES OF MALES AND FEMALES

This study's second hypothesis concerning the proposed inferior male performance on the auditory task gained some support, with a between-sex difference which was suggestive of there being a statistically significant difference between the performances of the female and male groups. Both the reading disabled and the non reading disabled male groups' mean Seashore Rhythm test scores (SRS) were lower than the female groups, and there was also a wider range of scores amongst the males. Both male groups had a greater standard deviation than their comparable female groups. Overall, the female individual Seashore Rhythm test scores ranged from 22 - 27, whilst the male individual scores ranged from 15 - 28. This greater range of scores was obvious over both male groups and not specific only to the reading disabled group.

These findings suggest that differences in auditory discrimination occur between the sexes, both reading disabled and non reading disabled. In other words, differences found between boys and girls may be, as was discussed earlier, dependent upon differing neural functioning between the sexes. A boy who performs poorly on an auditory perceptual task when he is compared to a girl of equivalent age and IQ may do so because of the sex difference rather than any predisposition he may have to a later reading disability. It could be proposed that the presence of a reading disability may widen the gap between his auditory discriminative ability and that of the female, however the results of this current study would not seem to support this as no significant difference between the auditory discriminative abilities of reading disabled and non reading disabled readers was found.

Consideration should also be given, at this stage, to the possible influences of the differing socialisation experiences of both sexes. It cannot be denied that, even as children, males and females experience differing expectations of what is considered to be appropriate behaviour. Whilst individual variations are to be expected, it is nevertheless true in the majority of cases that while males are more likely to be encouraged in experimenting with building, climbing and other active pursuits, females are more likely to experience encouragement in more language based activities e.g., reading, writing and oral language. It may be, therefore, that females show superior performance in auditory discriminative areas because of the added experience, and encouragement in language oriented tasks, they receive over the years. The skills which are encouraged amongst males e.g., mathematics ability, and tasks which develop the visuo-spatial ability, would not tend to be evident in this study when the area being assessed was auditorily based. The role of socialisation processes is acknowledged as a possible influence in the obtained results.

(III) IMPLICATIONS OF THE ABOVE FINDINGS, FROM THE LINKS BETWEEN LINGUISTIC AND MUSICAL FUNCTIONS

Whilst accepting the neuropsychological findings regarding the links between linguistic and musical functions, the ability difference noted between the males and females in this study adds some weight to the argument of a sex difference occurring in the development of early language based tasks thus affecting subsequent reading abilities. This helps to explain why the majority of children with the specific disability of dyslexia, are males. If males experience difficulty in discriminating between "same" and "different" rhythm patterns, then presumably their abilities in analysing a sequence of letters and sounds would also be poor. Bradley and Bryant's (1985) longitudinal study found this to be true when they analysed the sound categorisation skills (including rhyme and alliteration abilities) of 403 five and six year old children, at both pre-reading level and later after 4 years of reading and spelling tuition at school. Their results showed there was a definite relationship between a child's sound categorisation skills at pre-reading level and his/her eventual success at reading and spelling. It was apparent that positive early childhood experiences with rhyming and phonological awareness aided the development of successful reading skills later on.

As well as the language based areas, the implications of these findings in the field of music education obviously deserve some consideration. As discussed earlier, the beneficial value of early childhood musical exposure, experience and involvement cannot be overlooked. Not only are the qualities of the musical experience enjoyed for their own sake but there are ramifications in other academic areas as well. The disciplines involved obviously pay dividends when incorporated into other areas of the child's learning. Considering that the results of this study suggest differing perceptual and discriminative abilities between boys and girls, should some variations, additions or omissions in music education be implemented for males? Perhaps it would appear logical that the expectations we hold for our young male music students should vary from those we hold for our young female music students.

If we adhere to the idea of the benefits of early childhood music education, it would seem sensible that we aim to allow for such experience to be presented in a way to allow for maximal benefit to be drawn by <u>every</u> child. This may involve the addition to the curriculum of supplementary activities for the boys, in order to stimulate their left brain activities. After all, it is in the left hemisphere that superior (but not exclusive) processing of rhythmical stimuli takes place and the benefits of rhythmical exposure and experimentation should not be underemphasised. Such supplementary activities may involve i) extra verbal components, e.g., the addition of chanting to rhythmical passages rather than solely listening to them, ii) exposure to more logical and sequential concrete patterning to match auditorily presented rhythm patterns e.g., matching visually displayed block/bottle-top/cork patterns to auditorily presented stimuli, iii) focussing on the detail within the pattern (e.g., including soft and loud tones as well as rhythmic groupings) rather than just the pattern as a whole i.e., a focussed analytic approach rather than a wholistic one. Such activities are more condusive to left hemispheric rather than right hemispheric attention and as such would act to stimulate those areas possibly influencing more efficient rhythm pattern discrimination. It is, after all, an important aim to provide a child's educational opportunities in a way that allows the greatest benefit to be drawn. If this means that educational programmes should be adapted for either sex, then so be it!

Specific attention should be drawn to the first alternative suggested above i.e., the addition of extra verbal components. Indeed this addition was found by Atterbury to be beneficial when, in her 1983 study, she investigated the discriminative abilities of the reading disabled and the normal readers groups when using three different modes of input. It was found that the "tapped and spoken" mode (i.e., the "ta, ti-ti" approach) of presentation and input lead to a significantly improved performance rate of rhythmic passages, over the other two input modes of i) tapped only, and ii) melodic input. Atterbury concluded that if rhythm syllables were added to non-melodic rhythm patterns, children found the performance of these rhythm patterns easier.

(IV) LIMITATIONS OF THE CURRENT STUDY

All children in the current study were drawn from a larger population whom this study's researcher had assessed at the McKenzie Centre (for specifically learning disabled children and adults). Of the 45 children involved, 22 were classified as "reading disabled" whilst the other 23 were not i.e., the child's reading age was considered to be commensurate with his/her mental age. These 23 children were included in the control group. It should be acknowledged however that although for the purposes of this study the control group was not considered to be disabled in the reading area, there were other areas in which some of these children experienced differing degrees of language deficits. For example, some children had spelling difficulties (with no concomitant reading disabilities) whilst some others experienced difficulties in the area of written expression i.e., whilst their reading and spelling abilities were satisfactory, their ability to logically sequence ideas on paper and thus construct a written "story" was limited. It is important to acknowledge that these areas of deficit are language based and that their presence among the control children may have decreased any perceptual ability difference gap between their performances and those of the reading disabled children. In other words, the control group members used in this study were not "reading disabled" per se but some still experienced language difficulties which would make them more like the experimental groups (with regard to their difficulties) than would be ideal.

Reed (1989) addressed this point when she acknowledged that a substantial number of reading disabled children have subtle language difficulties as well as their reading disabilities and these disabilities may stem from varying degrees of perceptual problems. It is possible to argue, therefore, that such perceptual deficits may be sufficient to cause language problems more subtle that a reading disability e.g., varying degrees of phonological (un)awareness. Nevertheless, the perceptual deficit is still there and in the case of this present study may have served to "contaminate" the results of the control group.

If a control group of children (matched for age, sex, and intellectual ability) had been randomly selected from Christchurch schools it is possible that different results may have been gained. The question one must ask oneself is "Although the control group used in this study was a control group in that no reading disabilities were present, were they in fact a true control group considering the other language based disabilities which were present in some cases?" It would appear sensible to ask whether a child with no difficulties in any language based areas would initially present at McKenzie House for assessment anyway. One or two exceptions to this would be those children who present only for assessment of their intellectual ability because they are seeking referral to the Society for Gifted Children, or other specialist agencies, in which case the administration of a standardised intellectual assessment by a psychologist is recommended.

It may be possible that the finding of a non-significant difference between the rhythm pattern perception abilities of the experimental and the control groups in this study was influenced to some degree by the above conditions. The presence of language disabilities *other* than in the reading area may have served to mask any true differences in perceptual and discriminative abilities by lessening the perceived ability gap between the two groups. One suggestion would be to have had another control group as well as the two groups which were used. This would have allowed for analyses to have been carried out between the reading disabled group, the nonreading disabled but other language disabilities group (a heterogeneous group), and a control group of truly non language based disabled children. Clarification of the influences of the suspected other language based disabilities among the control group, as used, may then have been gained.

(V) DIRECTIONS FOR FUTURE RESEARCH

An interesting proposal for future research would be to investigate the possibility of sex differences in the ability to initally comprehend written musical notation. The pictorial nature of such notation could be seen to require more right hemispheric than left hemispheric functioning. As such, this could mean that the ability of males to interpret this visual representation would be superior to that of females. Or, if musical notation is read like any other written script or text, with left to right orientation and attention to detail in the written form, is it that the left hemisphere is more involved? It is possible that the level of exposure that an individual has had to the "reading" of musical notation may influence the location of cerebral functioning and so consideration would need to be given to the experience of the research subjects, with the primary aim being an investigation of functioning at the time of <u>initial</u> exposure. Results of such a study may provide another avenue through which left hemispheric activity could be seen to be stimulated.

As discussed previously in this study, future researchers in the field of reading and language based disabilities may do well to clarify specifically the group with whom they are working. Unfortunately the terminology used in this field of research is often not specific and so attempts at future comparisons between studies is hindered. As a group, those to whom we refer as being "learning disabled" are truly a heterogeneous group, thus requiring any researcher to specifically outline the criteria used for group and subject selection.

CONCLUSIONS

The results of this study suggest there may be a significant difference between the abilities of boys and girls on tasks of auditory perceptual and/or discriminative ability. The assessment measure used in this study does not allow for a clear distinction to be drawn between perception and discrimination per se, and so both processes must be acknowledged as being possibly influential in gaining the obtained results. In other words, a child may have perceived the rhythm pattern correctly but was unable to discriminate its patterning from that of its presented pair, or, the initial step of perception may have been dysfunctional thus detrimentally influencing the child's discrimination of the presented pair.

It is acknowledged that a variety of reasons may be proposed for the differences noted between the auditory perceptual abilities of the sexes. Indeed, it would be simplistic to attempt to identify a definite, single causal factor. The proposed explanations for these differences include the possibility of neural functioning differences between the sexes. These differences may help to explain why the majority of children who experience language based (including reading) disabilities are male. Maturational variations and differences in the patterning of neural functioning between the sexes help to explain the varying areas in which both sexes generally tend to excel or experience problems.

The neuropsychological data reviewed supports the idea of there being links between linguistic and musical functioning. As such, it appears logical to assume that the benefits accrued by those children who experience positive musical experience early in their education can be generalised to subsequent language based development. Appreciation of temporally presented material is a component which is shared by both areas, i.e., an appreciation of rhythm in the musical field is a basic component, and the ability to analyse a sequence (e.g., of sounds in letters and letters in words) is crucial in language based tasks.

The implications of this study include an acknowledgement of the role that Music Therapy may have to play in the remediation of language disabilities, (Rejto, 1973). With an appreciation of the heterogeneous nature of the population we refer to as "reading disabled", (with regard to causality), future research may pick up the challenge of investigating further the benefits which may be gained from musical education and experience.

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LIST OF APPENDICES

1 Introductory letters to parents requesting permission to involve their child in the proposed research.

2 Letter thanking parents for permission, including a date and time for their assessment.

3 Information sheet for parents regarding the aims of the research.

4 Consent form, - completed by parents.

5 Summary "File" page compiled for every child involved in the study. This was a summary sheet including all relevant data which allowed for easy and ready reference for the researcher.

6 Two Factor ANOVA (Analysis of Variance) table for Chronological Age, by Sex and Reading Ability.

7 Two Factor ANOVA (Analysis of Variance) table for Full Scale IQ, by Sex and Reading Ability.

8 Two Factor ANOVA (Analysis of Variance) table for Reading Age, by Sex and Reading Ability.

9 Raw test data

APPENDIX 1

Psychology Department
University of Canterbury
Private Bag
Ilam
CHRISTCHURCH

April 1990

Dear

I am a tester at the SPELD NZ Centre, McKenzie House, Christchurch. Under the auspices of the University of Canterbury, I am currently conducting a research project investigating a particular area of learning which relates to children with learning disabilities.

The study involves only children who have been previously assessed at McKenzie House and who are of a certain age. Both children with and without reading disabilities are required for this research. Each child is given a brief reading assessment as well as a short test of musical perception, - involving listening to a simple tape and reporting what he/she hears. The total time involved for each child is approximately 30-40 minutes.

I am writing to ask your permission to include .... in my research project. He/she would be required for only one 30-40 minute session, on an individual basis, to attend an assessment session at McKenzie House, 15 Rastrick Street, Christchurch 1. There is no cost involved and you are welcome to sit in on the assessment if you wish. An information sheet regarding the research study will be available at that time.

Could you please complete the attached form and return it to me at your earliest possible convenience, - preferably within one week of receiving this letter. You will be contacted again if you wish to be included in this study which will help to further our understanding of the problems experienced by our specifically learning disabled children. Your time and cooperation would be greatly appreciated.

Thank you.

Yours sincerely

....
Helen Butler

APPENDIX 2

Psychology Department
University of Canterbury
Private Bag
Ilam
CHRISTCHURCH

April 1990

Dear

Thank you for your prompt reply to my recent letter regarding my research project.

Please note that your appointment time is:

TIME: ....

DATE:..

Appointments are at McKenzie House, 15 Rastrick Street, Christchurch 1.

If this appointment time is not suitable, please contact McKenzie House, Ph: 554-424 and leave your name and contact number with the secretary.

Thank you.

Yours sincerely

....

Helen Butler

APPENDIX 3

THE AIMS OF THIS RESEARCH PROJECT (Copy for Parent/s)

The primary aim of this study is to investigate the differences between children who show some degree of reading deficit, and those who are reading at their age level, in their perception of rhythm patterns. We are not only interested in what the child hears but in how he/she understands what is heard.

The study's findings could have some implications for the teaching of music, and other subjects, to children with reading problems.

There will be approximately 60 children in this study. Any information we are able to gain regarding how children with reading problems process the information they receive will help in the ongoing quest to further understand why these problems exist.

Could you please complete the form on the second page of this handout and return it to me.

Each child will be given a brief reading assessment and then a short test of rhythm perception. The total testing time is approximately 30-40 minutes.

Thank you for your time and cooperation.

....

Helen Butler

APPENDIX 4

CONSENT FORM

I agree for my child, ... to participate in the project described above, on the understanding that if at any time I wish to withdraw .... from the experiment I may, without prejudice, do so.

All information collected will be confidential as will the identity of my child.

Signed: .... Date: ....

For my personal interest, I would/would not (please delete that which is not correct) appreciate a brief summary of the study's findings to be sent to me when the study is completed.

Summary to be sent to:

Mr/Mrs/Miss/Ms ....

Address ....

....

APPENDIX 5

FILE PAGE Exp....Cont...F / M

NAME: .... **DOB**: ....

ADDRESS: .... **AGE**: ....yrs ....mths

.... **PHONE**: ....

SCHOOL: .... **CLASS:** ....

TEACHER: ....

HEARING:..

VISION:..

****

FSIQ: (WISC-R) ....

MENTAL AGE: ....

READING AGE: ....

....

SEASHORE RHYTHM SCORE: (SRS)

....

ADDITIONAL COMMENTS:

....

APPENDIX 6

Anova table for a 2-factor Analysis of Variance on Y 1 : CA

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Sex (A)	1	28.722	28.722	.31	.5805
RD/Non RD (B)	1	.132	.132	.001	.9701
AB	1	51.508	51.508	.556	.4599
Error	41	3795.045	92.562		

There were no missing cells found.

APPENDIX 7

Anova table for a 2-factor Analysis of Variance on Y 1 : FSIQ

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Sex (A)	1	70.42	70.42	.725	.3995
RD/Non RD (B)	1	298.186	298.186	3.069	.0873
AB	1	5.762	5.762	.059	.8088
Error	41	3983.204	97.151		

There were no missing cells found.

APPENDIX 8

Anova table for a 2-factor Analysis of Variance on Y 1 : RA

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Sex (A)	1	207.526	207.526	1.208	.2782
RD/Non RD (B)	1	4528.53	4528.53	26.35	.0001
AB	1	55.046	55.046	.32	.5745
Error	41	7046.194	171.858		

There were no missing cells found.

APPENDIX 9

	Sex	RD/Non RD	CA	FSIQ	MA	RA	SRS
1	1	3	133	99	131	124	27
2	1	3	127	98	123	122	23
3	1	3	108	136	146	139	27
4	1	3	117	104	121	116	25
5	1	3	125	105	129	123	26
6	1	3	112	121	135	137	26
7	1	3	114	120	136	145	27
8	1	3	121	100	121	116	23
9	1	3	133	100	133	133	27
10	1	3	140	100	140	142	24
11	1	3	126	101	127	120	27
12	1	4	113	102	114	99	22
13	1	4	138	105	145	127	26
14	1	4	131	112	146	111	23
15	1	4	113	105	117	94	25
16	1	4	111	132	146	104	22
17	1	4	122	104	127	81	24
18	1	4	128	126	160	126	26
19	1	4	121	110	143	123	26
20	1	4	114	126	144	92	25
21	2	3	112	106	119	113	23
22	2	3	111	96	106	101	15
23	2	3	111	108	120	114	25
24	2	3	142	107	152	145	25
25	2	3	110	109	120	115	24
26	2	3	124	100	124	123	25
27	2	3	128	103	132	136	25
28	2	3	117	99	116	113	24
29	2	3	108	112	121	114	24
30	2	3	135	122	164	150	22
31	2	3	108	105	113	116	26
32	2	3	128	103	132	127	22
33	2	4	114	108	122	91	25
34	2	4	123	127	156	104	25
35	2	4	108	105	114	94	21
36	2	4	117	117	138	105	27
37	2	4	128	103	132	115	26
38	2	4	122	99	121	99	28
39	2	4	125	110	138	120	25
40	2	4	119	115	138	101	19
41	2	4	127	114	144	122	16
42	2	4	130	101	131	112	25
43	2	4	121	114	138	108	28
44	2	4	134	100	134	95	15
45	2	4	115	121	139	89	22

CA = Chronological age

FSIQ = Full Scale IQ

MA = Mental age

RA = Reading age

SRS = Seashore Rhythm score

(all ages are in months)

1 = female

2 = male

3 = non reading disabled

4 = reading disabled